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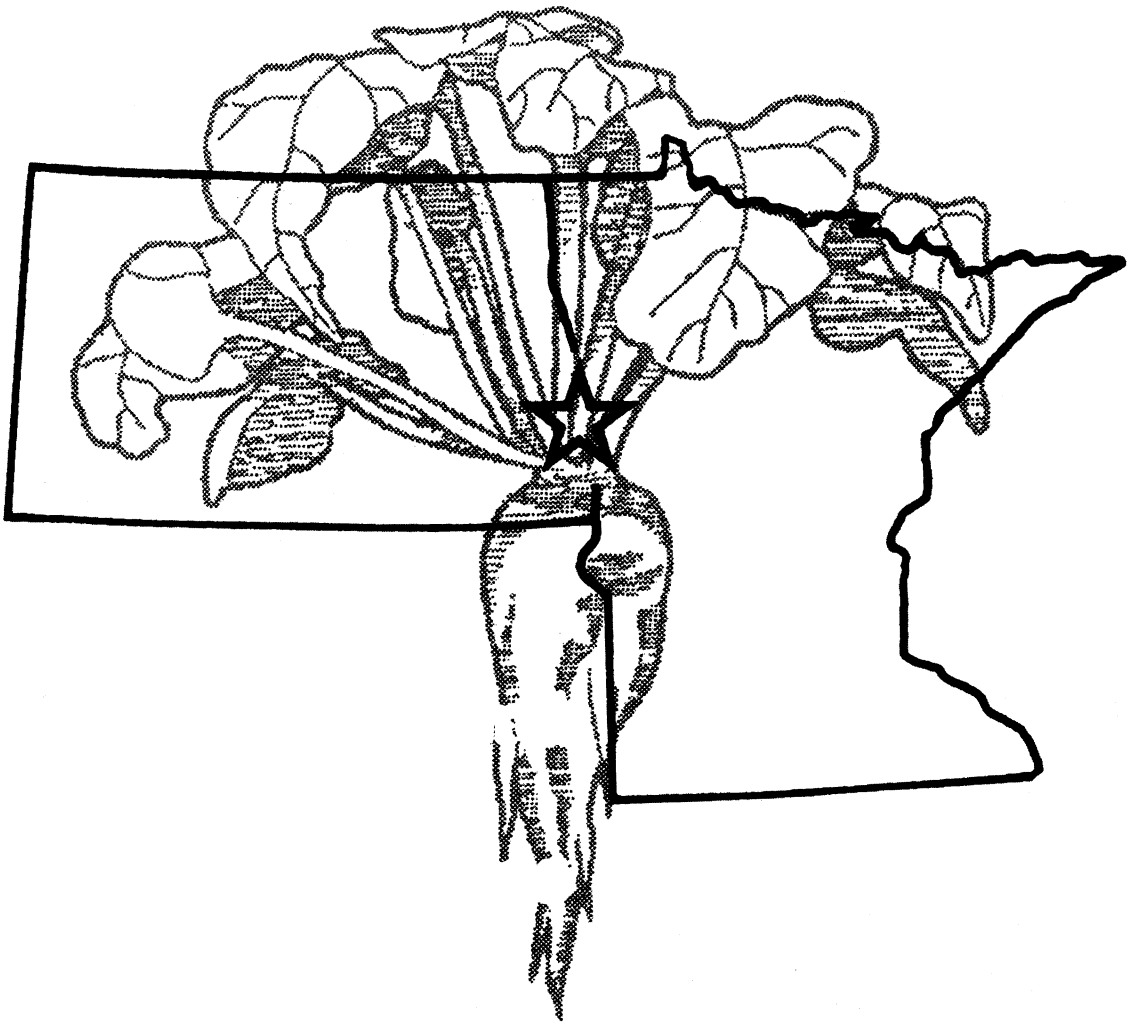

2025

Sugarbeet Research and Extension Reports

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WEED CONTROL

TURNING POINT SURVEY OF WEED CONTROL AND PRODUCTION PRACTICES IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2025

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The annual weed control and production practices live polling questionnaire was conducted using Turning Point Technology at the 2026 winter Sugarbeet Grower Seminars. Responses are based on production practices from the 2025 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 1–4). Survey results represent approximately 142,000 acres reported by 179 respondents (Table 5) compared with 199,000 acres in the 2025 survey and 210,000 acres represented in 2024. The average sugarbeet acreage per respondent was calculated from Table 5 at 793 acres, which is lower than the 855-acre average reported in 2025. Twenty-one percent of respondents planted 400–599 acres of sugarbeet, whereas only 4% reported planting 2,000 or more acres in 2025. Additional fungicide and insecticide questions were newly added to the 2026 Turning Point Survey (Tables 17–20); therefore, producer age demographics discussed in 2025 will be collected on a five-year basis.

Survey participants were asked a series of questions regarding their production practices used in sugarbeet in 2025. Growers were asked about their tillage practices for sugarbeet in 2025 (Table 6). Ninety-seven percent of all respondents indicated conventional tillage as their primary with 2% practicing strip tillage and 1% using no tillage. Across locations, 61% of respondents indicated wheat was the crop preceding sugarbeet (Table 7), 28% indicated corn (field and sweet) and ten-percent listed soybean. Preceding crops varied by location with 100% and 85% of Grand Forks and Fargo growers, respectively, indicating wheat preceded sugarbeet and 92% of Willmar growers indicated corn as their preceding crop. Thirty-six and twenty-two percent of Fargo and Grand Forks growers, respectively, who participated in the winter meetings used barley as a nurse or cover crop in 2025 (data not listed). Respondents at the Willmar and Wahpeton grower seminars were not surveyed regarding nurse or cover crop use in the 2025 survey.

Fifty-six percent of survey respondents indicated Cercospora leaf spot (CLS) as their most serious production problem (Table 8) in 2026 as compared with 16% of survey participants in 2024. Emergence and stand were named as the most serious overall by 15% of respondents across locations; however, emergence was the most serious problem for 34% of growers in Grand Forks. Twenty-three percent of respondents listed weeds as their most serious production challenge, contrary to fifty-two and fifty-four percent in 2024 and 2025, respectively.

Waterhemp was named as the most serious weed problem in sugarbeet for the sixth year in a row by 86% of respondents in 2026 (Table 9) as compared with 78% in 2025 and 76% in 2024. Kochia was rated as the most serious weed problem by 12% of respondents across all grower regions; 20% of Fargo growers and 18% of Grand Forks growers indicated kochia as their most challenging weed. The increased presence of glyphosate-resistant (GR) waterhemp and kochia, compounded by periods of hot and dry conditions followed by cool and wet conditions from May to June in 2024 caused multiple emergence flushes of both GR waterhemp and GR kochia (Ikley, personal communication 2026), which are likely the reasons for these weeds being named as the worst weeds. Grower regions south of Fargo are most affected by waterhemp; 96% of Willmar, 92% of Wahpeton, 80% of Fargo, and 74% of Grand Forks respondents indicated waterhemp as their most problematic weed. Waterhemp replaced kochia as the worst weed for 51% of respondents of the Grafton meeting (Drayton Factory District) in 2025. However, because Turning Point technology was not operational at the Grafton seminar, only 2025 Turning Point data are presented in the following; Thirty-seven percent of Grafton growers reported kochia as the most serious weed problem, 21% less than 2024. 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.

Preplant incorporated (PPI) or preemergence (PRE) herbicides were applied by 91% of survey respondents in 2025 (Table 10). Ethofumesate alone accounted for 40% of responses, S-metolachlor alone for 25%, and the combination of S-metolachlor plus ethofumesate for approximately 26%. Use of soil-residual herbicides continues to be a foundational practice across locations.

Regarding activation method of ethofumesate (Table 11), 48% of respondents applied ethofumesate PRE, while 22% did not apply ethofumesate. Mechanical incorporation methods such as field cultivator were used by 15% of growers, while 5% used vertical tillage, and harrow packer and multi-weeder implements used by six percent growers.

Sixty percent of growers indicated excellent (11%) to good (48%) weed control from soil-applied herbicides (Table 12). Twenty-five percent reported fair control, and ten percent indicated poor control. Thirty-five percent of respondents reporting fair to poor weed control from PPI or PRE applications creates weed control challenges later in sugarbeet development (Table 14). A lack of rainfall for chloroacetamide herbicide activation, particularly from May 2–May 14 and May 22–June 4 was recorded at the Wahpeton NDAWN Station. The absence of precipitation during these windows likely limited proper herbicide incorporation into the soil profile, reducing residual efficacy and overall weed control performance.

The application of soil-residual herbicides applied early postemergence (lay-by) to the 2025 sugarbeet crop was reported by over 96% of respondents (Table 13). S-metolachlor was applied early postemergence by 62% of growers, while 26% applied Outlook and 9% applied Warrant. S-metolachlor use was particularly high in Fargo (90%) and Grand Forks (81%), whereas Outlook was more common in Willmar (63%).

Lay-by applications are postemergence to sugarbeet and preemergence to small-seeded broadleaf weeds and typically occur from cotyledon to the 6- or 8-leaf sugarbeet stage. Soil residual chloroacetamide herbicides (SOA 15) remain the primary method for controlling Amaranthus species in sugarbeet. Despite responsible weed management, waterhemp escapes still occur. Across locations surveyed, 13% of respondents used inter-row cultivation, 7% Ultra Blazer, 35% hand-weeding, 14% electric weeder, and 26% of growers left it in the field (Table 16).

Fifty-eight percent of growers utilized some level of hand-weeding in 2025 (Table 14). Approximately 29% indicated less than 10% of their acres were hand-weeded, while 17% reported 10–50% of acres hand-weeded. Approximately twelve percent of growers reported more than 50% of acres hand-weeded.

Thirty-nine percent of participants reported some level of row-crop cultivation in 2025 (Table 15). Twenty-four percent of respondents indicated less than 10% of their acres were cultivated, whereas 3% reported cultivating 100% of their acres.

Rhizoctonia management in 2025 relied heavily on seed-applied protection, with 41% of respondents using seed treatment alone and twenty-two percent combining seed treatment with in-furrow applications (Table 17). Likewise, 22% of growers integrated POST fungicides with seed treatments and only 2% reported using a seed treatment plus in-furrow plus two POST applications. Among POST products (Table 18), 24% used Excalia and 18% used Quadris, while thirty-eight percent of respondents reported no POST fungicide. Twenty-nine percent of respondents made five fungicide applications for Cercospora leaf spot (Table 19). Forty-five percent of Grand Forks growers made six fungicide applications for Cercospora leaf spot control, while forty percent of Wahpeton growers made seven applications. Few (4%) respondents made eight or more fungicide applications.

Root maggot was the most frequently reported insect issue in 2025, accounting for 29% of responses overall and 62% in Grand Forks. Seventeen percent of respondents indicated Springtails and 14% indicated cutworms, while 9% responded grasshoppers and 5% Lygus bugs. Both, grasshoppers and Lygus bugs, were more localized to Wahpeton and Willmar growing regions. Approximately 20% of respondents selected “Other,” suggesting variable or region-specific insect pressures, particularly in Fargo and Wahpeton.

Table 1. 2026 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2025.

County	Number of Responses	Percent of Responses
Barnes	1	5
Becker	2	9
Cass	2	9
Clay	9	41
Norman[1]	6	27
Traill	2	9
Total	22	100

[1]Includes Mahnomen County.

Table 2. 2026 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2025.

County	Number of Responses	Percent of Responses
Grand Forks	6	17
Marshall	1	3
Polk[1]	21	60
Traill	2	6
Walsh	4	11
Other	1	3
Total	35	100

[1]Includes 1 Pennington County Respondent.

Table 3. 2026 Wahpeton Grower Seminar - Number of survey respondents by county growing sugarbeet in 2025.

County	Number of Responses	Percent of Responses
Cass	2	4
Clay	8	15
Grant	7	13
Richland	11	20
Roberts	1	2
Stevens	1	2
Traverse	2	4
Wilkin	22	41
Total	54	100

Table 4. 2026 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2025.

County	Number of Responses	Percent of Responses
Chippewa	30	30
Kandiyohi	6	6
Pope	1	1
Redwood	2	2
Renville	23	29
Stevens	4	5
Swift	8	10
Yellow Medicine	1	1
Other	4	5
Total	79	100

Table 5. Total sugarbeet acreage operated by respondents in 2025.

		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	20	0	5	0	5	20	25	10	20	10	5
Grand Forks	34	0	9	6	3	21	24	6	18	12	3
Wahpeton	51	4	8	6	8	25	16	14	16	4	0
Willmar	74	5	4	8	15	19	12	8	16	5	7
Total	179	3	6	6	10	21	17	1	17	7	4

Table 6. Tillage system used in sugarbeet in 2025.

Location	Responses	Conventional Tillage	Strip Tillage	No Tillage
		----------% of responses----------		
Fargo	21	95	5	0
Grand Forks	35	94	0	6
Wahpeton	52	96	4	0
Willmar	74	99	1	0
Total	182	96	3	1

Table 7. Crop grown in 2024 that preceded sugarbeet in 2025.

		Previous Crop					
Location	Responses	Sweet Corn	Field Corn	Dry Bean	Peas	Soybean	Wheat
		----------% of responses----------					
Fargo	20	0	0	0	0	15	85
Grand Forks	35	0	0	0	0	0	100
Wahpeton	52	0	21	0	0	17	62
Willmar	72	11	81	0	0	8	0
Total	179	3	26	0	0	10	62

Table 8. Most serious production challenge in 2025.

Location	Responses	Aph[2]	CLS[1]	Emerg[3]	Herbicide injury	Rhizoct[4]	Weeds	Root maggot
		----------% of responses----------						
Fargo	27	0	59	15	0	0	22	4
Grand Forks	64	2	76	5	2	4	11	0
Wahpeton	55	2	55	6	0	5	31	0
Willmar	83	2	34	34	0	2	28	0
Total	229	2	56	15	0	3	23	1

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

Table 9. Most serious weed problem in sugarbeet in 2025.

Location	Responses	grasses	colq[1]	cora	kochia	gira	rrpw	RR Canola	wahe	other
		----------% of responses----------								
Fargo	20	0	0	0	20	0	0	0	80	0
Grand Forks	34	0	0	6	18	0	0	3	74	0
Wahpeton	52	0	0	0	8	0	0	0	92	0
Willmar	70	1	0	0	0	2	0	0	96	1
Total	176	0	0	2	12	1	0	1	86	0

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

Table 10. Preplant incorporated or preemergence herbicides used in sugarbeet in 2025.

		PPI or PRE Herbicides Applied					
Location	Responses	*S*-metolachlor	ethofumesate	Ro-Neet SB	*S*-metolachor +ethofumesate	Other	None
		----------% of responses----------					
Fargo	25	12	52	0	36	0	0
Grand Forks	40	52	10	0	5	0	32
Wahpeton	65	26	38	0	34	0	2
Willmar	82	10	59	1	27	1	2
Total	212	25	40	0	26	0	9

Table 11. Activation method of ethofumesate applied preplant incorporated in 2025.

Location	Responses	Field Cultivator	Multi-weeder	Harrow-packer	Vertical Tillage	Other	Etho PRE	Did not apply etho
		----------% of responses----------						
Fargo	20	15	5	5	15	5	55	0
Grand Forks	31	6	0	6	0	3	10	74
Wahpeton	52	13	6	2	2	6	63	8
Willmar	77	25	1	0	3	5	62	4
Total	180	15	3	3	5	5	5	22

Table 12. Satisfaction in weed control from preplant incorporated and preemergence herbicides in 2025.

Location	Responses	PPI or PRE Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		----------% of responses----------					
Fargo	20	30	60	10	0	0	0
Grand Forks	36	0	58	19	6	0	17
Wahpeton	51	12	53	31	4	0	0
Willmar	69	1	22	39	30	1	6
Total	176	11	48	25	10	0	6

Table 13. Soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2025.

Location	Responses	Lay-by Herbicides Applied			
		S-metolachlor	Outlook	Warrant	None
		----------% of responses----------			
Fargo	20	90	5	0	5
Grand Forks	36	81	11	0	8
Wahpeton	57	72	23	5	0
Willmar	103	6	63	30	1
Total	216	62	26	9	4

Table 14. Percent of sugarbeet acres hand-weeded in 2025.

Location	Responses	% Acres Hand-Weeded				
		0	< 10	10-50	51-100	>100
		----------% of responses----------				
Fargo	21	48	38	14	0	0
Grand Forks	37	30	54	14	3	0
Wahpeton	50	66	10	16	8	0
Willmar	71	25	13	24	23	15
Total	179	42	29	17	9	4

Table 15. Percent of sugarbeet acres row-crop cultivated in 2025.

Location	Responses	% Acres Row-Cultivated				
		0	< 10	10-50	51-100	>100
		----------% of responses----------				
Fargo	20	70	30	0	0	0
Grand Forks	39	64	31	3	3	0
Wahpeton	51	69	16	12	4	0
Willmar	69	41	20	13	14	12
Total	179	61	24	7	5	3

Table 16. Rescue treatments used for escaped waterhemp in sugarbeet in 2025.

Location	Responses	Glyphosate Application Tank-Mixes					
		IRC[1]	Ultra Blazer	Hand labor	Electric weeder	Left[2]	No escapes
		----------% of responses----------					
Fargo	27	7	4	30	19	33	7
Grand Forks	47	11	0	47	4	30	9
Wahpeton	62	15	18	23	11	26	8
Willmar	116	17	6	41	20	14	2
Total	252	13	7	35	14	26	7

[1]Inter-row cultivation.
[2]Waterhemp escape left in field.

Table 17. What methods were used to control Rhizoctonia in 2025.

Location	Responses	Sd t[1]	Sd t + in-f	Sd t + POST	Sd t + in-f + POST	Sd t+ in-f + 2XPOST
		----------% of responses----------				
Fargo	20	40	25	15	15	5
Grand Forks	37	27	35	30	8	0
Wahpeton	50	76	12	8	4	0
Willmar	70	21	16	34	27	1
Total	177	41	22	22	14	2

[1]Seed treatment, seed treatment + in-furrow, seed treatment + POST, seed treatment + in-furrow + POST, seed treatment + in-furrow + 2xPOST.

Table 18. Which POST fungicide did you use to control Rhizoctonia in 2025.

Location	Responses	Azteroid	Azterknot	Excalia	Quadris	Proline	Elatus	Other	None
		----------% of responses----------							
Fargo	20	5	0	45	20	5	0	0	25
Grand Forks	40	4	0	2	10	4	0	2	78
Wahpeton	51	10	3	39	20	3	0	0	23
Wilmar	70	35	2	8	22	8	0	0	25
Total	181	14	1	24	18	5	0	1	38

Table 19. How many fungicide applications did you make to control Cercospora leaf spot in 2025.

Location	Responses	1	2	3	4	5	6	7	8	> 8
		----------% of responses----------								
Fargo	20	5	0	0	25	40	20	10	0	0
Grand Forks	51	0	0	2	6	35	45	10	0	2
Wahpeton	72	0	1	1	3	12	28	40	8	6
Wilmar	40	0	0	18	32	30	20	0	0	0
Total	183	1	0	5	17	30	28	15	2	2

Table 20. What was your worst insect problem in 2025.

Location	Responses	Armyw[1]	Cutw	Grassh	Lygus	Rtmggt	Sprtls	Wt G.	Wirew	Other
		----------% of responses ----------								
Fargo	18	11	17	0	0	17	22	0	0	33
Grand Forks	37	0	0	8	0	62	22	0	0	8
Wahpeton	45	7	20	29	2	9	7	4	4	18
Wilmar	73	0	21	1	19	**[2]	**	1	**	**
Total	173	4	14	9	5	29	17	1	1	20

[1]Armyworm, Cutworm, Grasshopper, Lygus Bugs, Root Maggot, Springtails, White Grubs, Wireworm, Other.
[2]Willmar grower seminar insects Armyworm = 1 % and Webworm = 0% and None = 56%.

OPTIMINZING WATERHEMP CONTROL WITH FALL APPLIED RESIDUAL HERBICIDES

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Summary

1. Dual Magnum fall applied at 2 pt/A or Eptam fall applied and incorporated at 5 pt/A when soil temperature at a 4-inch depth is less than 55F and falling.
2. Chloroacetamide herbicides applied POST to sugarbeet are required regardless of fall or spring PRE application.

Introduction

We have previously discussed inconsistency with ethofumesate. We attribute this to two chemical properties related to ethofumesate. First, ethofumesate has a K_{OC} value two-fold greater with than Outlook herbicide (dimethenamid-P) another chloroacetamide herbicide. K_{OC} is a chemical property measuring how strongly herbicide binds to organic matter in the soil compared to how much remains dissolved in soil water. Stated another way, ethofumesate binds tightly to organic matter and is less prone to leaching. Second, Outlook water solubility is 10 times greater than ethofumesate indicating moderate to high mobility in soil depending on soil organic matter content. It means ethofumesate likes to be attached to organic matter and takes a lot of rain to break loose.

Ways to improve ethofumesate consistency includes increasing the ethofumesate use rate, increasing water volume at application, and incorporating ethofumesate with tillage equipment. However, we wonder if we are incorporating the best group 15 herbicide if we activate with tillage and wonder if Eptam (EPTC) or Ro-Neet (cycloate) might be better candidates. Results from 2024 experiments suggest visible sugarbeet injury was greater when Eptam or Ro-Neet was applied at planting followed with the layby program as compared to ethofumesate PRE followed with the layby program (Peters and Aberle 2025). Further, waterhemp control was similar with both herbicide treatments.

It has been suggested we try fall application to improve waterhemp control (ethofumesate) or improve sugarbeet safety (Eptam). Eptam was applied on 71%, 54% and 40% of the acreage in 1982, 1983, and 1984, respectively, and fall applied Eptam accounted for 79%, 61% and 62% of the applied Eptam during those same years. The objectives of this experiment were a) to evaluate fall vs. spring applied Eptam, *S*-metolachlor and ethofumesate and b) to evaluate Eptam applied in a program approach with Outlook and Warrant as compared to ethofumesate or *S*-metolachlor, our current waterhemp control standard.

Materials and Methods

Experiments were initiated near Renville and Moorhead, MN and Hickson, North Dakota in October and November 2024 depending on location. The experimental area was prepared for fall herbicide application using a chisel plow for primary tillage followed by a field cultivator. At Renville, Eptam was applied and immediately incorporate to the appropriate depth. Once completed, the experimental area was tilled a second time to a 2-inch depth. At Hickson and Moorhead, Eptam was applied and the experimental area was tilled to properly incorporate Eptam and to provide uniform tillage treatment across the experimental area. Fall applied ethofumesate and Dual Magnum were applied after tillage (Table 1).

Eptam was applied similarly in the spring as the fall. After application, the experimental area was uniformly tilled to a 2-inch depth to remove emerged vegetation and to create a seedbed for planting. Sugarbeet was planted May 4 at Moorhead, May 6 at Renville, and May 7 at Hickson in 22-inch rows at approximately 63,500 seeds per acre with 4.5 inch spacing between seeds. Preemergence herbicides were applied immediately after planting. Postemergence herbicides were applied at the 2- and 6-lf stage.

Visible sugarbeet growth reduction injury was evaluated using a 0 to 99% scale (0 is no visible injury and 99 is complete loss of sugarbeet stand) and visible waterhemp control was evaluated using a 0 to 99 scale (0 is no control and 99 is complete control). We focused on sugarbeet growth reduction evaluation at Renville since weed pressure was light. Notes were collected until excessive rainfall flooded the experimental area in June. Waterhemp control

Table 1. Herbicide treatment, herbicide rate, application timing.

Trt Num	Herbicide Treatment[a,b]	Rate	Sugarbeet Stage[c]
		(pt or fl oz /A)	(lvs)
1	Ethofumesate + Dual Magnum / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	3 + 0.75 / 12 + 25 + 6 / 3 + 25 + 6	PRE/EPOST/ POST
2	Dual Magnum / RUPM3 + etho / RUPM3 + etho	2 / 25 + 6 / 25 + 6	Fall / 2 / 6
3	Ethofumesate / RUPM3 + etho / RUPM3 + etho	7.5 / 25 + 6 / 25 + 6	Fall / 2 / 6
4	Eptam / RUPM3 + etho / RUPM3 + etho	5 / 25 + 6 / 25 + 6	Fall / 2 / 6
5	Dual Magnum / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	2 / 12 + 25 + 6 / 3 + 25 + 6	Fall / 2 / 6
6	Ethofumesate / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	7.5 / 12 + 25 + 6 / 3 + 25 + 6	Fall / 2 / 6
7	Eptam / Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	5 / 12 + 25 + 6 / 3 + 25 + 6	Fall / 2 / 6
8	Eptam / ethofumesate/ Outlook + RUPM3 + etho / Warrant + RUPM3 + etho	5 / 4 / 12 + 25 + 6 / 3 + 25 + 6	Fall / PRE / 2 / 6
9	Dual Magnum / RUPM3 + etho / RUPM3 + etho	0.75 / 25 + 6 / 25 + 6	PRE / 2 / 6
10	Ethofumesate / RUPM3 + etho / RUPM3 + etho	6 / 25 + 6 / 25 + 6	PRE / 2 / 6
11	Eptam / RUPM3 + etho / RUPM3 + etho	2.5 / 25 + 6 / 25 + 6	Spring / 2 / 6

[a]Abbreviations, etho = ethofumesate; RUPM3 = Roundup PowerMax3
[b]Roundup PowerMax3 plus ethofumesate with non-ionic surfactant and Amsol liquid AMS at 0.25% + 2.5% v/v. PowerMax3 plus ethofumesate and either Outlook or Warrant with HSMOC and Amsol liquid AMS at 1 pt/A and 2.5% v/v.
[c]Fall=fall application, before or after tillage; Spring=spring application before tillage; PRE=after planting; 2=2-lf sugarbeet stage; 6=6-lf sugarbeet stage.

was collected at Hickson and Moorhead. Unfortunately, we were unable to collect sugarbeet injury at Hickson since sugarbeet stands were compromised by seed quality. Experiment was a randomized complete block design and 4 reps. Experiments were analyzed using Agricultural Research Manager (ARM) Revision 2025.5.

Results

We observed sugarbeet injury 36 days after planting (DAP) from treatments containing Outlook and Warrant applied at the 2- and 6-lf stage (Table 2). Injury was the same from Dual Magnum, ethofumesate, or Eptam fall applied in 2024 or ethofumesate mixed with Dual Magnum and applied preemergence in spring 2025. Sugarbeet injury was negligible with 2-times Roundup PowerMax3 application following fall applied Dual Magnum, ethofumesate or Eptam or Dual Magnum, ethofumesate or Eptam spring applied. Rain events on June 12, June 14, June 24, June 25 and June 28 caused flooding damage in replications one and two and caused unacceptable variability in replications three and four at the Renville location.

Waterhemp control was evaluated approximately weekly following Warrant application over 6- to 8-lf sugarbeet at Hickson and Moorhead. In general, Dual Magnum, ethofumesate, and Eptam followed by 2-times Roundup PowerMax3 treatments gave similar waterhemp control when applied in the fall and in the spring (Figure 1).

Table 2. Sugarbeet visible growth reduction injury in response to herbicide treatment, Renville MN 2025.[a]

Herbicide treatment[b]	Rate	Sugarbeet stage	24 DAP	36 DAP
	(pt/A)	Timing	(%)	(%)
Etho + Dual Magnum / Outlook / Warrant	3 + 0.75 / 0.75 / 3	PRE / EPOST / POST	23	24 a
Dual Magnum	2	Fall	10	5 b
Ethofumesate	7.5	Fall	5	5 b
Eptam	5	Fall	13	9 b
Dual Magnum / Outlook / Warrant	2 / 0.75 / 3	Fall / 2lf / 6lf	20	21 a
Etho / Outlook / Warrant	7.5 / 0.75 / 3	Fall / 2lf / 6lf	13	24 a
Eptam / Outlook / Warrant	5 / 0.75 / 3	Fall / 2lf / 6lf	15	24 a
Eptam / Etho / Outlook / Warrant	5 / 4 / 0.75 / 3	Fall / PRE / 2lf / 6lf	18	23 a
Dual Magnum	0.75	PRE	3	3 b
Ethofumesate	6	PRE	5	5 b
Eptam	2.5	Spring	15	8 b
LSD (0.10)			NS	9

[a]Sugarbeet injury followed by the same alphabetical letter indicates non-statistical differences between treatments at the 0.10 alpha level.
[b]Roundup PowerMax3 plus ethofumesate with non-ionic surfactant and Amsol liquid AMS at 0.25% + 2.5% v/v POST at V2 and V6 followed treatment. High surfactant methylated seed oil (HSMOC) at 1 pt/A was mixed with Roundup PowerMax3, ethofumesate and either Outlook or Warrant and Amsol liquid AMS.
[c]Abbreviations: etho=ethofumesate

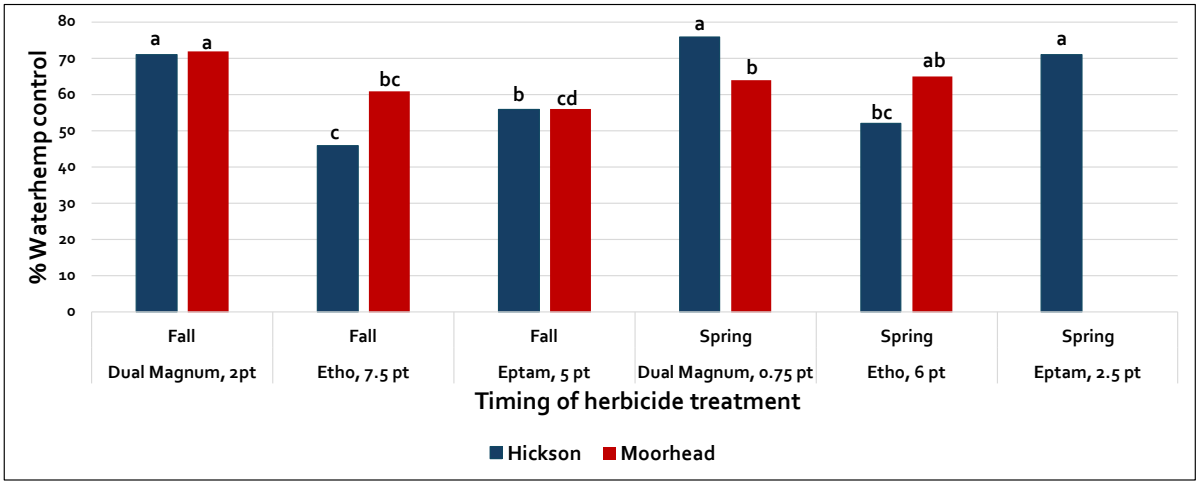

Figure 1. Waterhemp control in response to fall or spring applied treatment, 71 and 73 DAP, Hickson, ND and Moorhead, MN, 2025. Treatments sharing the same letter are the same at the 0.10 alpha level. All treatments contained 2-times Roundup PowerMax3 mixed with ethofumesate at the 2- and 6-lf stage.

However, what stands out is the consistency across locations from Dual Magnum, spring and fall applied. Waterhemp control from ethofumesate tended to be better at Moorhead than Hickson. Ethofumesate fall applied did not improve waterhemp control as compared to spring application. Eptam followed by 2-times Roundup PowerMax3 also appeared to provide consistent waterhemp control but control was less than Dual Magnum with fall application. We misapplied the Eptam spring application at Moorhead. Dual Magnum, Eptam and ethofumesate followed by 2-times Roundup POST treatments averaged 60% from fall application and 66% from spring applications.

Fall applied herbicides followed by the layby program was compared to our commercial standard, Dual Magnum plus ethofumesate followed by Outlook and Roundup PowerMax3 at the 2-lf stage and Warrant at the 6-lf stage standard (Figure 2). Fall applied Eptam, ethofumesate and Dual Magnum followed by Outlook mixed with Roundup PowerMax3 at the 2-lf stage and Warrant mixed with Roundup PowerMax3 provided waterhemp control similar to our Dual Magnum plus ethofumesate followed by Outlook and Roundup PowerMax3 at the 2-lf stage and Warrant at the 6-lf stage standard (Figure 2). Waterhemp control at Moorhead was better than Hickson but exceeded 90% with the exception of ethfomesate fall applied followed by the spring layby program at Hickson.

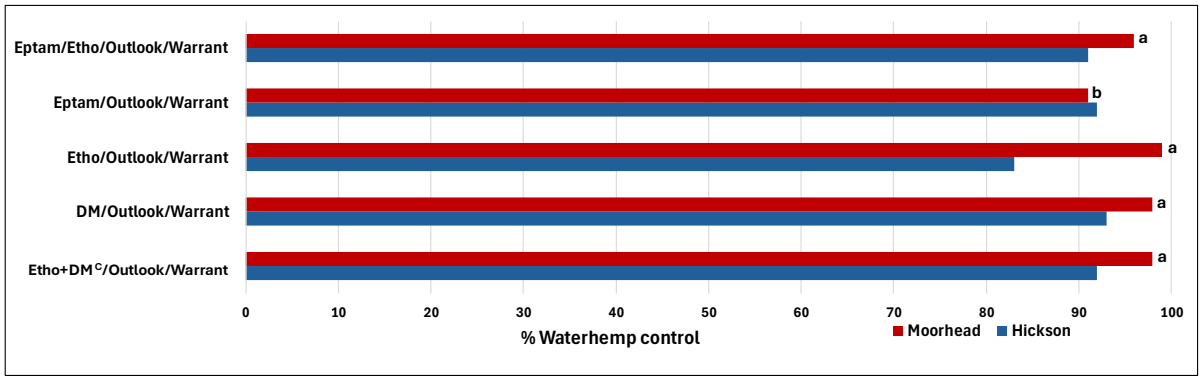

Figure 2. Waterhemp control in response to fall fb spring soil residual herbicides, Moorhead MN and Hickson ND, 2025. Treatments sharing the same letter are the same at the 0.10 alpha level. All treatments contained 2-times Roundup PowerMax3 mixed with ethofumesate at the 2- and 6-lf stage. Etho+DM was applied in the spring as a pre-emerge. All other treatments were fall applied.

Discussion

We observed lack of consistency with ethofumesate across locations when 2-times Roundup PowerMax 3 followed ethofumesate or when Outlook mixed with Roundup PowerMax3 at the 2-lf stage and Warrant mixed with Roundup PowerMax3 at the 6-lf stage. This is consistent with grower experiences. We observed more sugarbeet injury when chloroacetamide herbicides followed soil residual herbicides. There was no difference in sugar beet injury between fall and spring applied soil residual herbicides.

We recommend delaying the fall application for cool temperatures to reduce microbial degradation. Logic would indicate that delay may cause sugar beet injury in the spring. We are not certain that fall application replaces an at planting application. We also don't understand the accumulative effect of multiple soil residual herbicide applications on sugarbeet safety.

Literature Cited

Peters TJ, Aberle Adam (2025) Integrating Ro-Neet and Eptam Back into the Waterhemp Control Program in Sugarbeet. Sugarbeet Res. Ext. Rept. 55:12-17

SUGARBEET TOLERANCE FROM HERBICIDE MIXTURES WITH INSECTICIDES AND FUNGICIDES

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Summary

1. Excalia for rhizoctonia damping off control mixed with herbicides and insecticides caused less vegetative sugarbeet injury than Quadris mixed with herbicides and insecticides.
2. Vegetative injury from complex mixtures sometimes but not always caused loss of sugarbeet root yield.
3. Foliar fungicides for control of Cercospora leaf spot mixed with pesticides for control of weeds and insects did not cause vegetative injury or reduce root yield or sucrose content in these experiments.
4. Product selection matters with complex tank-mixtures; differences in active and inert ingredients can influence crop tolerance.

Introduction

Sugarbeet is among the most complicated crops to cultivate, requiring a rigorous and precisely timed pest management program to achieve maximum root yield and sucrose content. Efficient time management and strategic pesticide use remain primary concerns for sugarbeet producers, as postemergence weed control frequently overlaps with soilborne and foliar disease and insect control. Growers regularly inquire about herbicide tank-mixtures of three, maybe four active ingredients. These mixtures may also include a soil-borne fungicide for Rhizoctonia root and crown rot control or an insecticide for root maggot or cutworm control. We are also receiving questions about herbicide and insecticide mixtures with foliar applied fungicides for Cercospora leaf spot as the recommendations to initiate spray programs creep into mid-June. Interest in complex tank-mixtures as a method to enhance operational efficiency and reduce application costs continues to grow, making evaluation of sugarbeet tolerance to complex tank-mixtures a primary focus for research.

Although these practices can reduce trips across the field, combining products with different formulation types, preloaded adjuvant systems, and percent active ingredient may increase the risk of physical incompatibility or crop phytotoxicity. Sugarbeet is particularly sensitive to many of its own registered pesticides and may exhibit phytotoxic responses, especially when formulations contain higher concentrations of oil-based adjuvants or surfactant systems that can increase herbicide uptake and crop injury potential (Kniss 2018). This is especially prevalent with cool and cloudy environmental conditions that slow the metabolism of pesticides by sugarbeet.

Evaluation of sugarbeet tolerance to herbicide-insecticide-fungicide tank-mixtures across multiple locations is necessary to inform best management practices and minimize the risk of crop injury under field conditions. The objectives of this research were: a) evaluate sugarbeet tolerance from herbicide mixtures with soilborne fungicides and insecticides; and b) evaluate sugarbeet tolerance from herbicide mixtures with foliar disease fungicides and insecticides.

Materials and Methods

Field experiments were conducted at multiple locations in the 2025 growing season to evaluate sugarbeet vegetative tolerance, root yield and sucrose content from herbicide mixtures with soilborne fungicides and insecticides. Greenhouse experiments conducted in 2022, (Peters et al., Sgbt Res. Ext. Rept. 2022:53:55-59, Peters et al., Sgbt Res. Ext. Rept. 2022:53:60-62,) 2023 and 2024 complement these field experiments. Experiments were arranged as a randomized complete block design (RCBD) with six replications. Ethofumesate was broadcast preemergence at 6 pints per acre (pt/A) to provide season-long weed control, ensuring high quality data. All other insect and disease pests were actively managed in experiments. Applications were made using a CO_2-pressurized backpack or bicycle sprayer calibrated to deliver 17 gallons per acre (gpa). Application dates and weather information are listed below (Table 3).

Soilborne Disease Complex Mixtures. Pesticide application was timed to the 4- to 6-leaf (lf) stage (Table 1). A 'base' herbicide treatment, Roundup PowerMax3 mixed with ethofumesate and Outlook at 30 + 12 + 18 fl oz/A, respectively, was added to all treatments. Additional pesticides were Excalia, Quadris, Asana XL, and Stinger HL either tank-mixed with 'base' or following 'base' by three days. Treatments containing Excalia or Quadris with Stinger HL and Asana XL included Amsol liquid AMS at 2.5% v/v. Table 3 are weather conditions at application. Experiments were conducted near Prinsburg, Brushvale, and Crookston, MN. Prinsburg and Brushvale were planted in the typical timeframe when sugarbeet are planted in MN. Unfortunately, Crookston was replanted June 11, 2025 due to stand challenges associated with weather.

Table 1. Pesticide treatment, pesticide rate, and timing of pesticide application.

Pesticide treatment[a,b]	Rate	Sugarbeet stage
	--------fl oz/A)--------	(lf stage)
Roundup PowerMax3 + ethofumesate + Outlook (Base)	30 + 12 + 18	4 to 6
Base + Excalia	2	4 to 6
Base + Excalia + Asana XL	2 + 9.6	4 to 6
Base + Excalia + Stinger HL	2 + 2.4	4 to 6
Base + Excalia + Asana XL + Stinger HL	2 + 9.6 + 2.4	4 to 6
Base + Quadris	15	4 to 6
Base + Quadris + Asana XL	15 + 9.6	4 to 6
Base + Quadris + Stinger HL	15 + 2.4	4 to 6
Base + Quadris + Asana XL + Stinger HL	15 + 9.6 + 2.4	4 to 6
Base / Excalia + Asana XL + Stinger HL (3 DAB)	2 + 9.6 + 2.4	4 to 6 / 3 DAB
Base / Quadris + Asana XL + Stinger HL (3 DAB)	15 + 9.6 + 2.4	4 to 6 / 3 DAB

[a]Roundup PowerMax3 + ethofumesate + Outlook + Stinger HL and Excalia or Quadris with HSMOC at 1 pt/A + AMS at 2.5% v/v. Roundup PowerMax3 + etho + Outlook + Excalia or Quadris and Stinger HL + Asana with AMS at 2.5% v/v.
[b]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB)

Foliar Disease Complex Mixtures. Pesticide application was timed to the 8- to 10-leaf stage (Table 2). A base herbicide treatment for waterhemp control consisted of Roundup PowerMax3 mixed with ethofumesate and Warrant at 22 + 6 fl oz/A and 3 pt/A, respectively. Additional pesticides were Mustang Max, Manzate Pro-Stick, Select Max, and Proline either tank-mixed with 'base' or following 'base' by 3 days. All treatments included Prefer 90 non-ionic surfactant, at 0.25% v/v, and Amsol liquid AMS at 2.5% v/v. Table 3 are weather conditions at application. Experiments were conducted near Brushvale, MN and Prosper, ND. Brushvale was planted May 6, 2025. Unfortunately, Prosper was replanted June 11, 2025 due to stand challenges manifested by May 2025 environmental conditions.

Data Collection. Sugarbeet stand counts were collected from the middle two rows of each 30-ft plot at the 2- to 4-

Table 2. Pesticide treatment, pesticide rate, and timing of pesticide application.

Pesticide treatment[a,b]	Rate	Sugarbeet stage
	--(fl oz or lb or pt/A)--	(lf stage)
Roundup PowerMax3 + ethofumesate + Warrant (Base)	22 + 6 + 3 pt	8 to 10
Base + Mustang Max	4	8 to 10
Base + Manzate Pro-Stick	2 lb	8 to 10
Base + Mustang Max + Manzate Pro-Stick	4 + 2 lb	8 to 10
Base + Mustang Max + Manzate Pro-Stick + Select Max	4 + 2 lb + 16	8 to 10
Base + Manzate Pro-Stick + Proline	2 lb + 5.7	8 to 10
Base + Mustang Max + Manzate Pro-Stick + Proline	4 + 2 lb + 5.7	8 to 10
Base / Manzate Pro-Stick (3 DAB)	2 lb	8 to 10
Base + Mustang Max / Manzate Pro-Stick (3 DAB)	4 / 2 lb	8 to 10 / 3 DAB
Base + Mustang Max / Manzate Pro-Stick + Select Max (3 DAB)	4 / 2 lb + 16	8 to 10 / 3 DAB
Base / Manzate Pro-Stick + Proline (3 DAB)	2 lb + 5.7	8 to 10 / 3 DAB
Base + Mustang Max / Manzate Pro-Stick + Proline (3 DAB)	4 / 2 lb + 5.7	8 to 10 / 3 DAB

[a]Roundup PowerMax3 + ethofumesate + Warrant mixed with Mustang Max, Manzate Pro-Stick and/or Proline with Prefer 90 nonionic surfactant at 0.25% v/v and Amsol liquid AMS at 2.5% v/v. Manzate Pro-Stick and/or Proline with Prefer 90 nonionic surfactant at 0.25% v/v 3 days after base (DAB).
[b]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB)

Table 3. Temperature (F) and relative humidity (%) at pesticide application.

Soilborne Disease Complex Mixtures									Foliar Disease Complex Mixtures					
Crookston, MN			Brushvale, MN			Prinsburg, MN			Prosper, ND			Brushvale, MN		
Date	F	%	Date	F	%	Date	F	%	Date	F	%	Date	F	%
7/8	68	58	6/18	74	57	6/5	75	34	7/24	87	55	7/1	74	79
7/14	70	65	6/24	65	59	6/10	63	68	7/29	82	54	7/9	82	59

leaf stage and again prior to harvest. Crop response was visually evaluated for malformation, chlorosis, necrosis, and growth reduction using a 0 to 99% scale, where 0 represented no visible injury compared to glyphosate control and 99% represented complete plant or stand loss relative to the glyphosate control. Evaluations were conducted at approximately 3, 7, and 14 days after treatment. At harvest, sugarbeet was defoliated, harvested mechanically from 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) or the Quality Lab at Southern Minnesota Beet Sugar Cooperative (Renville, MN). Single location experiments were analyzed using Agricultural Research Manager (ARM.2025.5). Combined data analysis was done using the GLIMMIX procedure in Statistical Analysis Software (SAS 9.4).

Results

Soilborne Disease Complex Mixtures. We observed necrosis, malformation and growth reduction sugarbeet injury from pesticide treatments (Table 4, Figures 1, 2 and 3). However, we did not observe visible chlorosis injury from treatments. Sugarbeet necrosis injury (P=<0.0001) differed among Quadris and Excalia treatments. Visible necrosis is death of sugarbeet tissues characterized by dark brown or black, dry, brittle, and often sunken patches. Growth reduction also separated treatments. Growth reduction was greatest with treatments containing Quadris; Quadris mixed with Stinger HL or Quadris mixed with Stinger HL plus Asana XL and Roundup PowerMax3, ethofumesate and Outlook. Growth reduction from Excalia alone or tank-mixes with Excalia mixed with Roundup PowerMax3, ethofumesate and Outlook was the same as Roundp PowerMax3, ethofumesate and Outlook alone. We observed leaf malformation, auxin mimic injury as many treatments contained Stinger HL. However, injury wasn't completely related to Stinger HL. Necrosis caused distortion of sugarbeet that was noted as malformation injury. Malformation injury was greater or tended to be greater when Quadris was mixed with pesticide treatments as compared to Excalia mixed with treatments.

Table 4. Visible necrosis, malformation and growth reduction in response to pesticide treatment, averaged across Prinsburg and Crookston, MN, 2025.[a]

Pesticide treatment[b,c]	Rate	% Necrosis	% Malform	% Gr Red	% Gr Red
	---(fl oz/A)----	2 to 8 DAAB	2 to 8 DAAB	2 to 8 DAAB	13 to 22DAAB
Roundup PowerMax3 + ethofumesate + Outlook (Base)	30 + 12 + 18	14 b	12 d	12 e	10 cd
Base + Excalia	2	16 b	16 cd	12 e	6 c
Base + Excalia + Asana XL	2 + 9.6	13 b	17 bcd	14 de	9 cd
Base + Excalia + Stinger HL	2 + 2.4	18 b	24 bcd	21 cd	13 cd
Base + Excalia + Asana XL + Stinger HL	2 + 9.6 + 2.4	15 b	27 bcd	19 cde	18 bc
Base + Quadris	15	38 a	30 abc	38 b	24 ab
Base + Quadris + Asana XL	15 + 9.6	35 a	29 abc	36 b	25 ab
Base + Quadris + Stinger HL	15 + 2.4	44 a	45 a	48 a	30 a
Base + Quadris + Asana XL + Stinger HL	15 + 9.6 + 2.4	43 a	33 ab	40 b	30 a
Base / Excalia + Asana XL + Stinger HL (3 DAB)	2 + 9.6 + 2.4	12 b	33 ab	23 c	18 bc
Base / Quadris + Asana XL + Stinger HL (3 DAB)	15 + 9.6 + 2.4	22 b	25 bcd	21 cd	16 bcd
P-Value		0.0001	0.0068	0.0001	0.0001

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.05 alpha level.

[b]Base treatment added to the treatment comparisons was Roundup PowerMax3 mixed with ethofumesate and Outlook at 30 + 12 + 18 fl oz/A. Roundup PowerMax3 + ethofumesate + Outlook + Stinger HL and Excalia or Quadris with HSMOC at 1 pt/A + AMS at 2.5% v/v. Roundup PowerMax3 + etho + Outlook + Excalia or Quadris and Stinger HL + Asana with AMS at 2.5% v/v.

[c]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB)

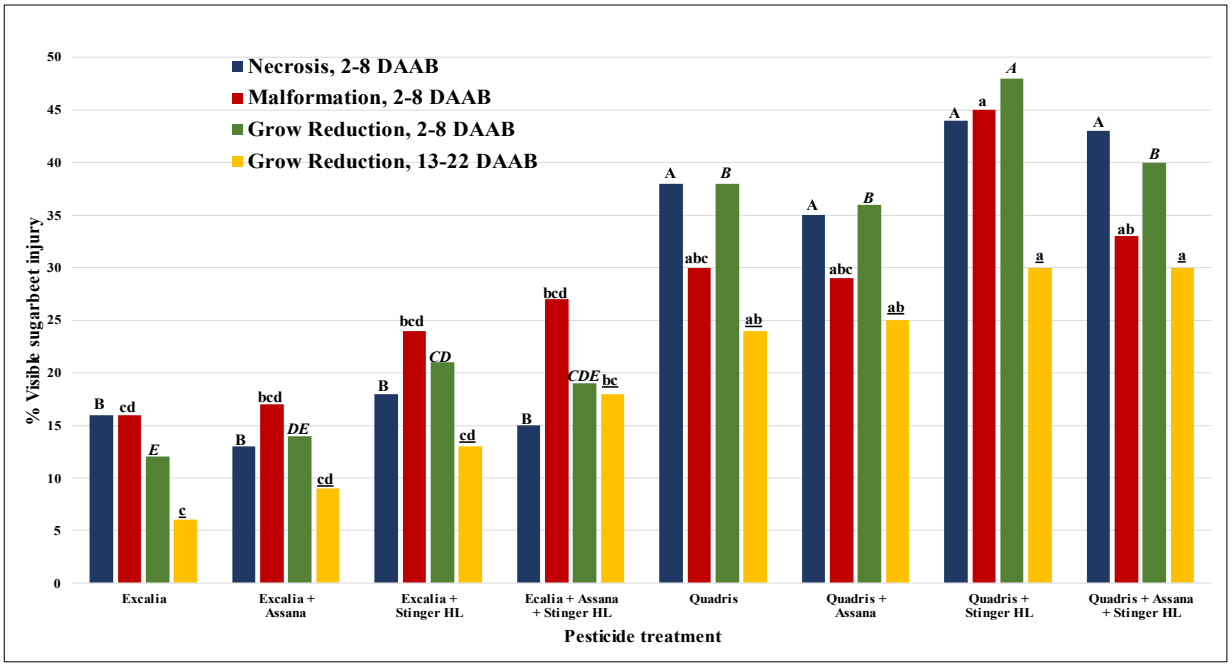

Figure 1. Visible necrosis, malformation and growth reduction in response to pesticide treatment, averaged across Prinsburg and Crookston, MN, 2025.

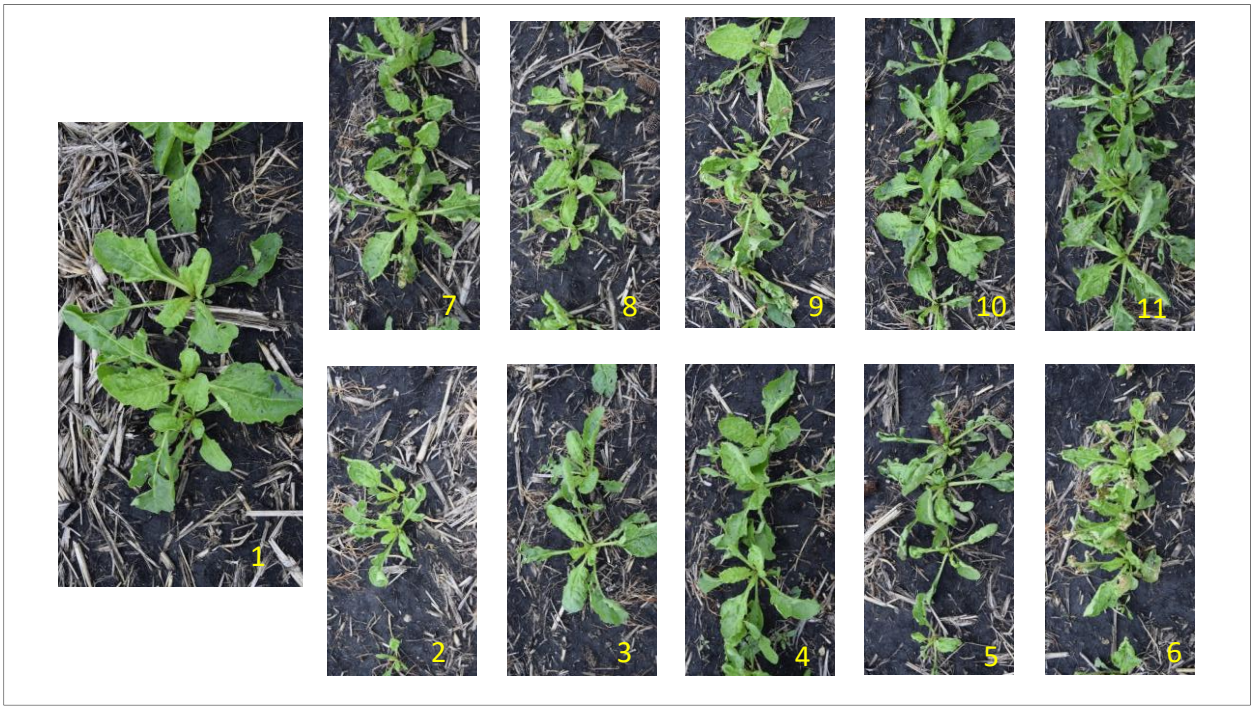

Figure 2. Sugarbeet injury in response to herbicide treatment, 2 DAAB, Prinsburg, MN, 2025. Image number corresponds to treatment number. Treatment 1 is the base herbicides treatment, Roundup PoweMax3 with ethofumesate and Outlook. Excalia (trt 10) or Quadris (trt 11) mixed with Asana and Stinger HL was applied 3 days after base treatment.

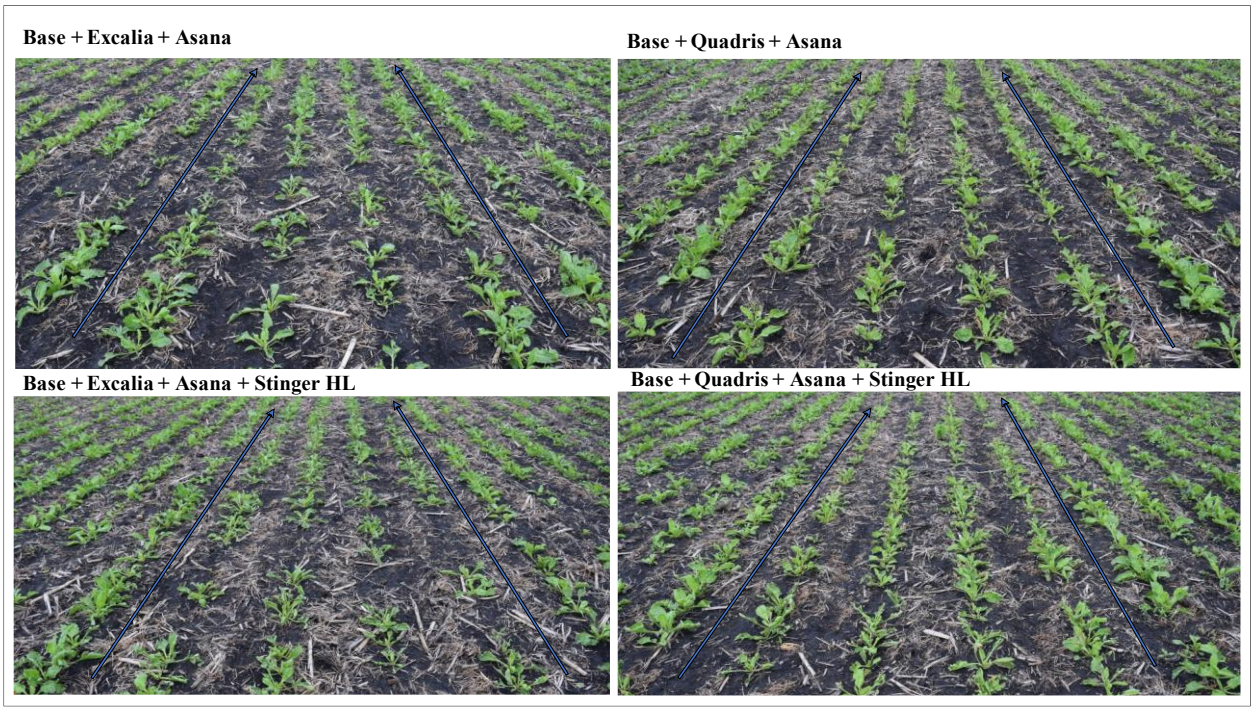

Figure 3. Growth Reduction injury in response to pesticide treatment, Prinsburg, MN, 2025.

Root yield differed across treatments and locations (Table 5 and Figure 4) (P=0.0869, Crookston and P=0.0180, Prinsburg). At Crookston, treatments recovered from early season sugarbeet injury. At Prinsburg, treatments with Quadris mixed with Asana XL, Stinger HL and Asana XL and Stinger HL plus Roundup PowerMax3, ethofumesate and Outlook had root yield less or root yield that tended to be less than Excalia mixed with Asana XL, Stinger HL and Asana XL and Stinger HL plus Roundup PowerMax3, ethofumesate and Outlook. We attribute root yield differences to weather conditions in 2025. Prinsburg received greater than 30-inch rainfall after planting as compared to 15 inches at Crookston. Further, Prinsburg received four rainfall events of greater than 3-inch rain. Sugarbeet must metabolize applied pesticides. Pesticide metabolism is much slower when sugarbeet are not actively growing due to cool temperatures, cloudy skies and saturated soils.

Table 5. Root yield and % sucrose in response to pesticide treatment, Crookston and Prinsburg, MN, 2025.[a]

Pesticide treatment[b,c]	Rate	Root yield (TPA)		% Sucrose	
	----(fl oz/A)----	Crookston	Prinsburg	Crookston	Prinsburg
Roundup PowerMax3 + ethofumesate + Outlook (Base)	30 + 12 + 18	30.4 abc	27.7 a-d	18.0	14.3
Base + Excalia	2	30.3 abc	29.0 ab	17.9	14.2
Base + Excalia + Asana XL	2 + 9.6	31.0 ab	29.6 a	18.2	14.2
Base + Excalia + Stinger HL	2 + 2.4	31.3 a	28.6 ab	17.7	14.4
Base + Excalia + Asana XL + Stinger HL	2 + 9.6 + 2.4	30.7 abc	27.9 abc	17.4	14.3
Base + Quadris	15	29.7 cd	27.5 bcd	17.8	14.6
Base + Quadris + Asana XL	15 + 9.6	29.8 bcd	26.5 cde	17.7	14.5
Base + Quadris + Stinger HL	15 + 2.4	29.0 d	25.6 de	17.7	14.6
Base + Quadris + Asana XL + Stinger HL	15 + 9.6 + 2.4	30.9 abc	25.1 e	18.1	14.3
Base / Excalia + Asana XL + Stinger HL (3 DAB)	2 + 9.6 + 2.4	31.1 a	27.7 a-d	17.6	14.6
Base / Quadris + Asana XL + Stinger HL (3 DAB)	15 + 9.6 + 2.4	30.4 abc	27.8 a-d	18.1	14.5
P-Value		0.0869	0.0180	0.7298	0.1243

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Base treatment added to the treatment comparisons was Roundup PowerMax3 mixed with ethofumesate and Outlook at 30 + 12 + 18 fl oz/A. Roundup PowerMax3 + ethofumesate + Outlook + Stinger HL and Excalia or Quadris with HSMOC at 1 pt/A + AMS at 2.5% v/v. Roundup PowerMax3 + etho + Outlook + Excalia or Quadris and Stinger HL + Asana with AMS at 2.5% v/v.
[c]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB)

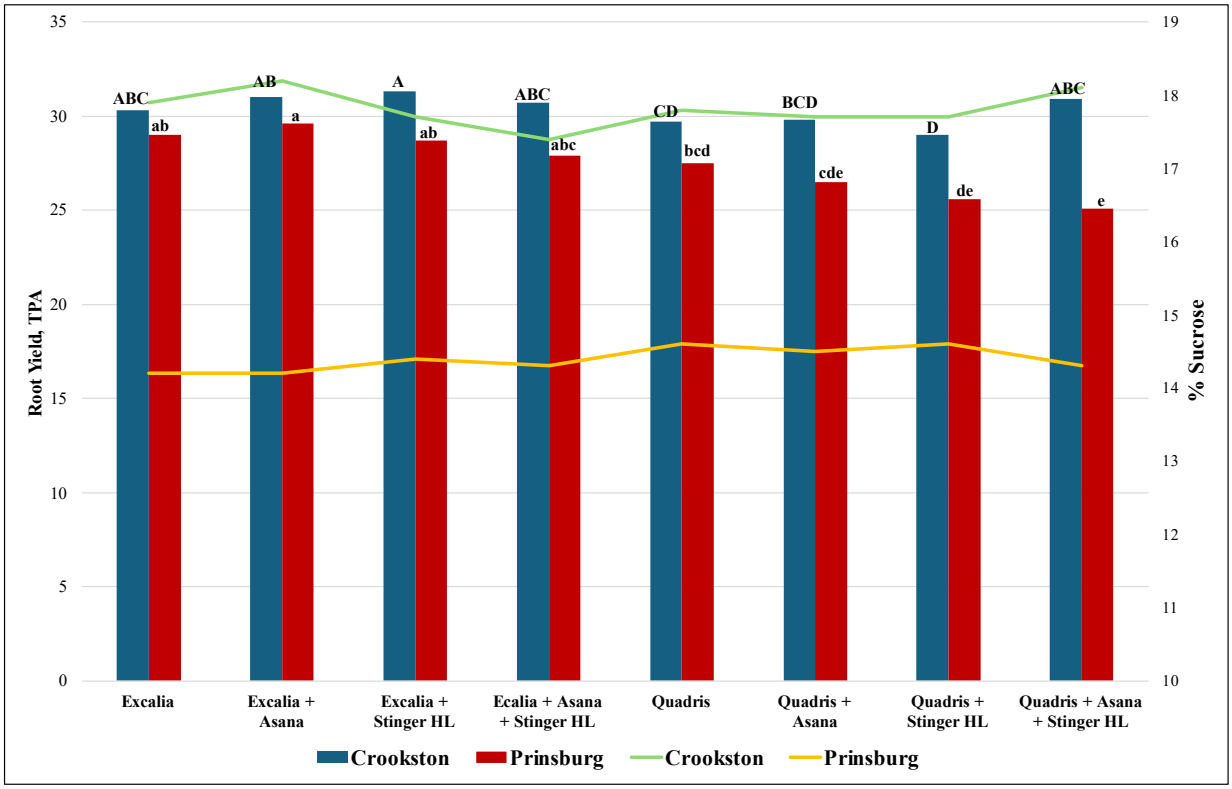

Figure 4. Root yield (tons per acre) and % sucrose content in response to pesticide treatment at Crookston and Prinsburg, MN. Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.

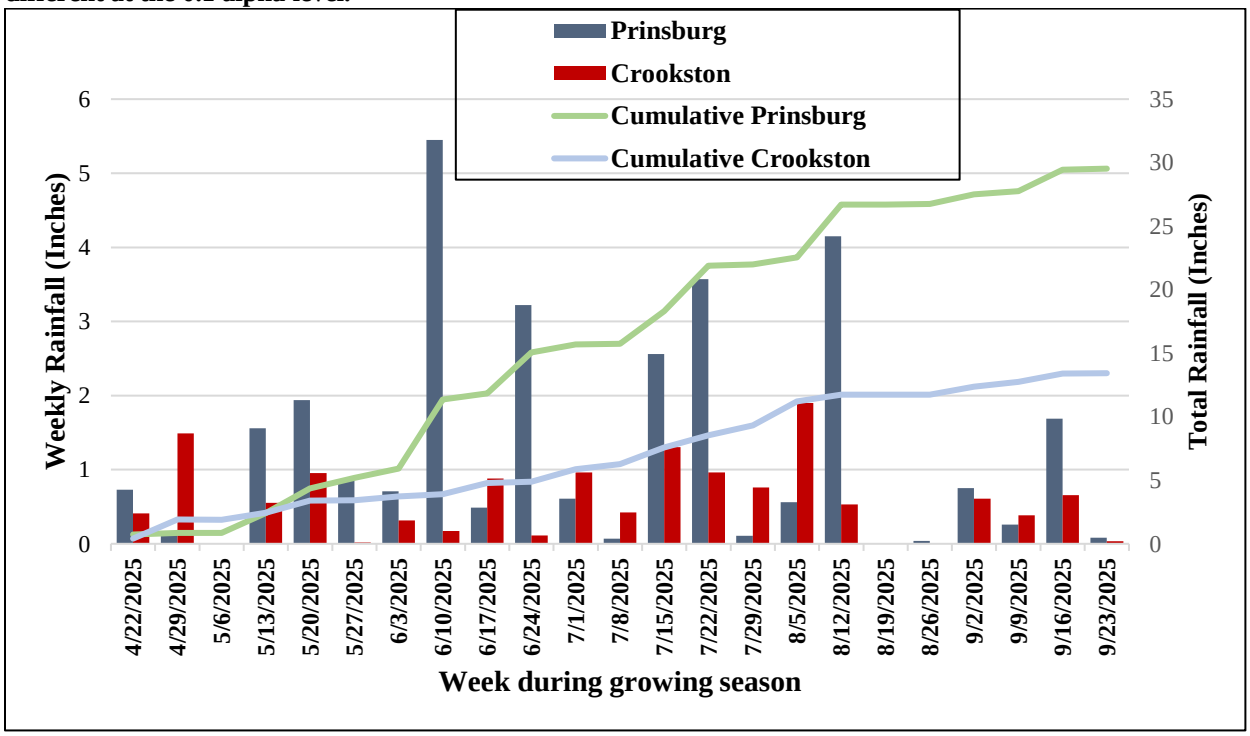

Figure 5. Rainfall (inch) and cumulative rainfall (inch) at Prinsburg and Crookston, MN, 2025. Data collected from the North Dakota Agricultural Weather Network (Crookston) and from on-site weather instrumentation (Prinsburg).

We elected not to include the Brushvale location in the combined analysis. Sugarbeet stands and resultant root yields were much more variable at Brushvale as compared to Prinsburg or Crookston. We observed similar sugarbeet necrosis, malformation, and growth reduction with treatments containing Quadris and Stinger HL (Table 6). In general, sugarbeet necrosis and growth reduction injury was greater when Quadris was mixed with Asana XL, Stinger HL or Asana XL and Stinger HL with Roundup PowerMax3, ethofumesate and Outlook as compared to Excalia mixed with Asana XL, Stinger HL or Asana XL and Stinger HL with Roundup PowerMax3, ethofumesate and Outlook. We observed much more malformation injury from treatments containing Stinger HL at Brushvale or distortion caused by necrosis injury from treatments containing Quadris mixed with Asana XL, Stinger HL or Asana XL and Stinger HL with Roundup PowerMax3, ethofumesate and Outlook at Brushvale than Prinsburg or Crookston.

Table 6. Visible percent necrosis, malformation and growth reduction in response to pesticide treatment, Brushvale, MN, 2025.[a]

Pesticide treatment[b,c]	Rate	Necros	Malform	Gr Red	Malform	Gr Red
	----(fl oz/A)----	--------(% 6 DAAB)--------			----(% 13 DAAB)----	
Roundup PowerMax3 + ethofumesate + Outlook (Base)	30 + 12 + 18	2 d	7 c	3 e	3 e	3 c
Base + Excalia	2	3 d	7 c	8 e	5 de	8 bc
Base + Excalia + Asana XL	2 + 9.6	5 d	8 c	3 e	0 e	3 c
Base + Excalia + Stinger HL	2 + 2.4	0 d	28 b	12 de	11 cd	5 c
Base + Excalia + Asana XL + Stinger HL	2 + 9.6 + 2.4	0 d	31 b	9 de	8 de	8 bc
Base + Quadris	15	33 a	25 b	33 a	23 ab	23 a
Base + Quadris + Asana XL	15 + 9.6	29 ab	31 b	26 abc	18 bc	15 ab
Base + Quadris + Stinger HL	15 + 2.4	28 ab	45 a	33 a	26 a	22 a
Base + Quadris + Asana XL + Stinger HL	15 + 9.6 + 2.4	28 b	39 a	31 ab	11 cd	15 ab
Base / Excalia + Asana XL + Stinger HL (3 DAB)	2 + 9.6 + 2.4	0 d	26 b	18 cd	3 e	8 bc
Base / Quadris + Asana XL + Stinger HL (3 DAB)	15 + 9.6 + 2.4	14 c	41 a	23 bc	3 de	8 bc
P-Value		0.0001	0.0001	0.0001	0.0001	0.0035

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Base treatment added to the treatment comparisons was Roundup PowerMax3 mixed with ethofumesate and Outlook at 30 + 12 + 18 fl oz/A. Roundup PowerMax3 + ethofumesate + Outlook + Stinger HL and Excalia or Quadris with HSMOC at 1 pt/A + AMS at 2.5% v/v. Roundup PowerMax3 + etho + Outlook + Excalia or Quadris and Stinger HL + Asana with AMS at 2.5% v/v.
[c]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB)

Table 7. Sugarbeet stand, root yield, % sucrose and recoverable sucrose per acre in response to pesticide treatment, Brushvale, MN, 2025.[a]

Pesticide treatment[b,c]	Rate	Stand	Root yield	% Sucrose	Rec Sucrose
	----(fl oz/A)----	Num per 20 ft row	Tons per acre	%	lb/acre
Roundup PowerMax3 + ethofumesate + Outlook (Base)	30 + 12 + 18	31	27.7	16.1 a	5,996
Base + Excalia	2	28	26.5	15.9 ab	5,322
Base + Excalia + Asana XL	2 + 9.6	29	30.01	15.9 ab	6,529
Base + Excalia + Stinger HL	2 + 2.4	28	29.6	16.1 a	6,423
Base + Excalia + Asana XL + Stinger HL	2 + 9.6 + 2.4	28	29.2	16.1 a	6,203
Base + Quadris	15	26	27.0	16.0 a	5,466
Base + Quadris + Asana XL	15 + 9.6	30	26.8	15.7 ab	4,998
Base + Quadris + Stinger HL	15 + 2.4	30	27.5	15.6 bc	5,230
Base + Quadris + Asana XL + Stinger HL	15 + 9.6 + 2.4	28	26.9	15.2 c	5,075
Base / Excalia + Asana XL + Stinger HL (3 DAB)	2 + 9.6 + 2.4	26	27.4	15.6 bc	5,414
Base / Quadris + Asana XL + Stinger HL (3 DAB)	15 + 9.6 + 2.4	28	30.3	16.0 ab	6,101
P-Value		0.8362	0.3704	0.0308	0.1172

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Base treatment added to the treatment comparisons was Roundup PowerMax3 mixed with ethofumesate and Outlook at 30 + 12 + 18 fl oz/A. Roundup PowerMax3 + ethofumesate + Outlook + Stinger HL and Excalia or Quadris with HSMOC at 1 pt/A + AMS at 2.5% v/v. Roundup PowerMax3 + etho + Outlook + Excalia or Quadris and Stinger HL + Asana with AMS at 2.5% v/v.
[c]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB)

Foliar Disease Complex Mixtures. Sugarbeet vegetative injury was visible necrosis and growth reduction injury that was negligible at both Brushvale and Prosper (Table 8). Likewise, root yield, % sucrose content and recoverable sucrose reduction where not treatment related or consistent across locations (Table 9).

Table 8. Sugarbeet stand, and percent visible sugarbeet injury in response to pesticide treatment, Bruvale MN and Prosper ND, 2025.[a]

Pesticide treatment[b,c]	Rate	Sugarbeet stand		Grow Red 3-5 DAA		Grow Red 5-10 DAB	
	---(fl oz or lb or pt/A)---	Brushvale (Nu/20 ft)	Prosper (Nu/20 ft)	Brushvale (%)	Prosper (%)	Brushvale (%)	Prosper (%)
Roundup PowerMax3 + ethofumesate + Warrant (Base)	22 + 6 + 3 pt	25	57	8 ab	3	5	2 b
Base + Mustang Max	4	22	56	12 a	0	3	0 b
Base + Manzate Pro-Stick	2 lb	21	57	2 cd	3	3	2 b
Base + Mustang Max + Manzate Pro-Stick	4 + 2 lb	24	56	5 bc	3	0	4 b
Base + Mustang Max + Manzate Pro-Stick + Select Max	4 + 2 lb + 16	25	58	3 cd	6	8	3 b
Base + Manzate Pro-Stick + Proline	2 lb + 5.7	20	56	2 cd	0	0	2 b
Base + Mustang Max + Manzate Pro-Stick + Proline	4 + 2 lb + 5.7	24	55	2 cd	4	0	2 b
Base / Manzate Pro-Stick (3 DAB)	2 lb	24	60	0 d	4	0	0 b
Base + Mustang Max / Manzate Pro-Stick (3 DAB)	4 / 2 lb	24	58	2 cd	9	3	5 b
Base + Mustang Max / Manzate Pro-Stick + Select Max (3 DAB)	4 / 2 lb + 16	23	61	2 cd	3	2	0 b
Base / Manzate Pro-Stick + Proline (3 DAB)	2 lb + 5.7	25	60	0 d	0	3	5 b
Base + Mustang Max / Manzate Pro-Stick + Proline (3 DAB)	4 / 2 lb + 5.7	24	60	2 cd	3	0	11 a
P-Value		0.8337	0.4343	0.0009	0.3495	0.3310	0.0751

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Roundup PowerMax3 + ethofumesate + Warrant mixed with Mustang Max, Manzate Pro-Stick and/or Proline with Prefer 90 nonionic surfactant at 0.25% v/v and Amsol liquid AMS at 2.5% v/v. Manzate Pro-Stick and/or Proline with Prefer 90 nonionic surfactant at 0.25% v/v.
[c]Abbreviations: Base = Roundup PowerMax3 + ethofumesate + Warrant. DAB = days after base treatment. DAA = days after application A. DAB = days after application B.

Discussion

Soilborne disease complex mixtures demonstrated that formulation type, active ingredient–preventative or locally systemic, and cumulative adjuvant load influenced sugarbeet tolerance. Although treatments contained the same herbicide base, mixtures with Quadris resulted in greater growth reduction, necrosis, and lower root yield compared to Excalia treatments. These differences likely reflect formulation chemistry and herbicide and fungicide behavior within sugarbeet. Emulsifiable concentrate (EC) formulations and products with preloaded surfactant systems

Table 9. Root yield, % sucrose and recoverable sucrose in response to pesticide treatment, Brushvale, MN and Prosper, ND, 2025.[a]

Pesticide treatment[a,b]	Rate	Root yield		% Sucrose		Rec Sucrose	
	---(fl oz or lb or pt/A)---	Brushvale Tons/A	Prosper Tons/A	Brushvale %	Prosper %	Brushvale lb/A	Prosper lb/A
Roundup PowerMax3 + ethofumesate + Warrant (Base)	22 + 6 + 3 pt	21.3 cd	21.7	14.9 ef	15.6 ab	3,267	3,840
Base + Mustang Max	4	20.5 d	22.3	16.0 a	15.9 a	3,184	3,955
Base + Manzate Pro-Stick	2 lb	22.0 bcd	22.6	15.0 def	14.9 c	3,313	3,634
Base + Mustang Max + Manzate Pro-Stick	4 + 2 lb	22.6 a-d	22.4	15.0 def	15.6 ab	3,519	3,940
Base + Mustang Max + Manzate Pro-Stick + Select Max	4 + 2 lb + 16	23.5 abc	23.2	14.9 f	15.9 ab	3,549	4,227
Base + Manzate Pro-Stick + Proline	2 lb + 5.7	22.1 bcd	22.7	15.6 abc	15.7 ab	3,456	4,087
Base + Mustang Max + Manzate Pro-Stick + Proline	4 + 2 lb + 5.7	24.7 a	22.1	15.4 b-e	15.5 ab	4,200	3,902
Base / Manzate Pro-Stick (3 DAB)	2 lb	24.1 ab	21.9	15.3 c-f	15.8 ab	4,137	3,879
Base + Mustang Max / Manzate Pro-Stick (3 DAB)	4 / 2 lb	24.8 a	20.6	15.4 b-e	15.5 b	4,353	3,208
Base + Mustang Max / Manzate Pro-Stick + Select Max (3 DAB)	4 / 2 lb + 16	22.5 a-d	22.5	15.8 ab	15.4 bc	3,891	3,841
Base / Manzate Pro-Stick + Proline (3 DAB)	2 lb + 5.7	23.0 abc	22.7	15.5 bcd	15.7 ab	3,899	4,319
Base + Mustang Max / Manzate Pro-Stick + Proline (3 DAB)	4 / 2 lb + 5.7	20.6 d	21.4	15.4 b-e	15.1 b	3,048	3,567
P-Value		0.0509	0.3978	0.0037	0.0738	0.1918	0.2008

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Roundup PowerMax3 + ethofumesate + Outlook + Stinger HL and Excalia or Quadris with HSMOC at 1 pt/A + AMS at 2.5% v/v. Roundup PowerMax3 + etho + Outlook + Excalia or Quadris and Stinger HL + Asana with AMS at 2.5% v/v.
[c]Excalia or Quadris mixed with Asana XL and Stinger HL 3 days after base (DAB).

enhance cuticle penetration; when multiple oil-containing products are combined, the cumulative solvent and adjuvant load can unintentionally "stack" cuticle penetrants in the spray solution. Sugarbeet has a narrow margin of crop safety to postemergence herbicides (Kniss 2018), and excessive penetration may accelerate active ingredient uptake beyond the metabolic capacity of sugarbeet, increasing cellular injury. The necrosis observed in Quadris treatments, a translaminar QoI fungicide, suggests that increased tissue penetration under high oil spray solutions may increase phytotoxicity. In contrast, Excalia-containing mixtures caused minimal vegetative injury and maintained higher root yield, indicating more favorable compatibility with the herbicide and adjuvant system.

Results reinforce that complex tank-mixtures should be constructed based on both economic pest pressure and formulation compatibility. Each additional active ingredient contributes not only another mode of action but also additional solvents, surfactants, or oil-based components that may increase phytotoxic risk. Avoiding unnecessary stacking of EC formulations or oil-containing products is critical, particularly under conditions that favor rapid uptake. Product inclusion should be justified by expected economic return. For example, in fields with a history of Rhizoctonia and early-season weeds such as common lambsquarters, a mixture of glyphosate + ethofumesate + Excalia may be warranted. However, if insect pressure such as sugarbeet root maggot is low, adding an insecticide may increase cumulative oil load and induce sugarbeet phytotoxicity. Strategic product selection remains essential to preserving crop safety while maintaining operational efficiency in soilborne disease complex programs.

Foliar fungicides for control of Cercospora leaf spot mixed with pesticides for control of weeds and insects did not cause vegetative injury or reduce root yield or sucrose content in these experiments. Minor, transient growth reduction was observed in a few treatments, but injury dissipated and considered negligible. Applications occurred at the 8- to 10-leaf stage, when sugarbeet plants have greater leaf area, ticker cuticles, and metabolic capacity, which likely enhanced tolerance and recovery compared with earlier growth stages in soilborne disease complex mixture treatments.

Despite sugarbeet safety, careful product selection is essential. Certain fungicides used for Cercospora leaf spot can influence sugarbeet tolerance, especially when mixed with other actives or oil-based formulations, including pyraclostrobin (Headline® fungicide) and tin-based products such as triphenyltin hydroxide and organotin compounds (Hernandez et al. 2024). However, it is unlikely these products would be used for late June control of Cercospora leaf spot and thus, would not be candidates for mixture with glyphosate, ethofumesate or chloroacetamide herbicides.

Cercospora leaf spot fungicides may contain translaminar or systemic formulations that penetrate leaf tissue. The cumulative effect can unintentionally "stack" cuticle penetrants when fungicides are combined with other penetrative herbicides and insecticides or oil-based emulsifiable concentrates and adjuvants. This enhances herbicide uptake, increasing the risk of phytotoxicity in sugarbeet.

Literature Cited

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SUGARBEET TOLERANCE FROM STINGER HL ALONE AND IN MIXTURES

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Summary

1. Increasing the Stinger HL rate from 1.8 to 3.2 fl oz/A increased malformation injury 0 to 7 days after the repeat Stinger HL application but did not reduce root yield or sucrose content.
2. Two-times S-metolachlor or Select Max mixed with Stinger HL, Roundup PowerMax3 and ethofumesate increase sugarbeet injury and affected certain yield perimeters.
3. We encourage applicators to consider environmental conditions at application and make the appropriate adjustment.

Introduction

Stinger HL (clopyralid) is a very important herbicide for sugarbeet growers due to its activity on four families of plant species, acteracea or the aster, daisy or sunflower family, fabaceae or the legumes family, polygonaceae or knotweed or smartweed family and the solanacea or nightshade family. Stinger HL is very effective for control of plants in these families including common ragweed, biennial wormwood, Canada thistle, and nightshade, as examples. Stinger HL does not provide control of waterhemp or common lambsquarters.

Several challenges compromise Stinger HL use. First, Stinger HL, like other auxin mimic herbicides, is often applied below labeled rates. Second, some believe Stinger HL causes sugarbeet injury under warm and humid conditions, especially once sugarbeet reach the 6-lf stage. Third, the window of application is narrow, cotyledon to 8-lf stage. Sugarbeet growers attending the 2024 Production Seminars identified glyphosate resistant (GR) common ragweed at their most important weed control challenge on 2% of the acres or 12,493 aces. However, 22% identified common ragweed as the first or second most important weed in Crookston and EGF factory districts. Further, we have observed extended common ragweed germination and emergence patterns, especially in 2024 and 2025. An extended emergence window requires growers make two Stinger HL applications in sugarbeet. In many cases Stinger HL will be applied in mixtures with other herbicides.

Our 'best practices' for Stinger HL application are Stinger HL at 2.4 fl oz/A with a single application timed to common ragweed less than 2-inch in diameter. We suggest 2-times Stinger HL at 1.8 fl oz/A at the 2-lf and 8-lf application. Finally, we suggest timing Stinger HL application to ragweed size rather than sugarbeet stage. Thus, you may need to separate glyphosate and Stinger HL application if you want to delay termination nurse crop to 4-lf sugarbeet. The objectives of this research were: a) to evaluate sugarbeet tolerance, root yield and % sucrose content from 2-times Stinger HL in sugarbeet at 3 Stinger HL use rates or b) to evaluate sugarbeet tolerance, root yield and % sucrose content from Stinger HL mixed with Roundup PowerMax3 alone, Stinger HL and Roundup PowerMax3 mixed with Select Max or Stinger HL and Roundup PowerMax3 mixed with S-metolachlor.

Materials and Methods

A tolerance experiment was conducted at Crookston, Brushvale, and Prinsburg, MN and Prosper, ND in 2025. 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 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.

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 malformation and growth reduction was evaluated as 'sugarbeet injury' approximately 7 and 14 days after treatment (DAT) using a 0 to 99% injury scale (0% denoting no

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

Trt Num	Postemergence herbicide[ab]	Rate	Sugarbeet stage
		(fl oz/A)	(lf stage)
1	Stinger HL + RUPM3 / Stinger HL + RUPM3	1.8 + 25 / 1.8 + 25	2 / 6-8
2	Stinger HL + RUPM3 / Stinger HL + RUPM3	2.4 + 25 / 2.4 + 25	2 / 6-8
3	Stinger HL + RUPM3 / Stinger HL + RUPM3	3.2 + 25 / 3.2 + 25	2 / 6-8
4	Stinger HL + Select Max + RUPM3/ Stinger HL +Select Max + RUPM3	2.4 + 10 + 25 / 2.4 + 10 + 25	2 / 6-8
5	Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	2.4 + 16 + 6 + 25 / 2.4 + 16 + 6 + 25	2 / 6-8
6	Ethofumesate / Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	96 / 2.4 + 16 + 6 + 25 / 2.4 + 16 + 6 + 25	2 / 6-8
7	RUPM3 + etho / RUPM3 + etho	25 + 6 / 25 + 6	2 / 6-8

[a]Stinger HL was mixed with Roundup PowerMax3 plus Prefer 90 NIS and Amsol liquid AMS at 0.25% v/v and 2.5% v/v. Stinger HL was mixed with Roundup PowerMax3 and Select Max with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v. Stinger HL, Roundup PowerMax3, *S*-metolachlor and ethofumesate were mixed with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.
[b]Abbreviations: RUPM3=Roundup PowerMax3; etho=ethofumesate

sugarbeet injury and 99% denoting complete loss of sugarbeet stature). All evaluations were a visible 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) or 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 the Crookston, Brushvale and Prinsburg locations since variance were similar with these three experiments. We elected not to use the Brushvale experiment in our combined analysis due to variation attributed to sugarbeet stand. Data from the Brushvale experiment are in separate tables Data was analyzed using the GLIMMIX procedure in Statistical Analysis Software (SAS 9.4) (Cary, NC).

Results

Stinger HL mixed with Roundup PowerMax3, vegetative tolerance. We observed greater malformation and growth reduction injury from Stinger HL mixed with Roundup PowerMax3 1 to 7 days after application C (DAAC) than 9 to 14 DAAC (Table 2, Figures 1 and 2). In general, malformation and growth reduction injury were similar but greater with Stinger HL at 2.4 and 3.1 fl oz/A than with Stinger HL at 1.8 fl oz/A. Evaluation was visible injury using a 0% to 100% scale. I considered 10%, 20% and 30% malformation minor, just an increase in intensity of leaf curling. Values of 40% and 50% were more significant and affect how future leaves unroll. Sometimes I will observe leaf damage attributed to the inability of leaves to unroll. Scores of 60% or 70% was damage that may affect petioles. Sometimes we see bent petioles or leaves on the ground. Growth reduction was greater or tended to be greater with 2-times Stinger HL at 2.4 and 3.2 fl oz/A mixed with Roundup PowerMax3 (Table 2, Figure 4).

Table 2. Visible percent growth reduction and malformation in response to treatment, averaged across Crookston and Prinsburg, MN and Prosper, ND, 2025.[a]

Treatment[b]	Rate	Growth Reduction	Malforma-tion	Growth Reduction	Malforma-tion
	fl oz/A	--(1 to 7 DAAC)--		--(9 to 14 DAAC)--	
Stinger HL + RUPM3 / Stinger HL + RUPM3	1.8+25/1.8+25	11 e	21 d	5 c	9 c
Stinger HL + RUPM3 / Stinger HL + RUPM3	2.4+25/2.4+25	11 de	28 bc	13 b	19 b
Stinger HL + RUPM3 / Stinger HL + RUPM3	3.2+25/3.2+25	17 cd	32 b	11 b	21 b
Stinger HL + Select Max + RUPM3/ Stinger HL +Select Max + RUPM3	2.4+10+25/ 2.4+10+25	21 c	26 cd	16 b	19 b
Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	2.4+16+6+25/ 2.4+16+6+25	29 b	49 a	29 a	34 a
Ethofumesate / Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	96/2.4+16+6+25/ 2.4+16+6+25	37 a	49 a	29 a	33 a
RUPM3 + etho / RUPM3 + etho	25+6/25+6	6 e	2 e	4 c	1 d
P-Value		<0.0001	<0.0001	<0.0001	<0.0001

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.05 alpha level.
[b]Stinger HL was mixed with Roundup PowerMax3 plus Prefer 90 NIS and Amsol liquid AMS at 0.25% v/v and 2.5% v/v. Stinger HL was mixed with Roundup PowerMax3 and Select Max with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v. Stinger HL, Roundup PowerMax3, S-metolachlor and ethofumesate were mixed with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

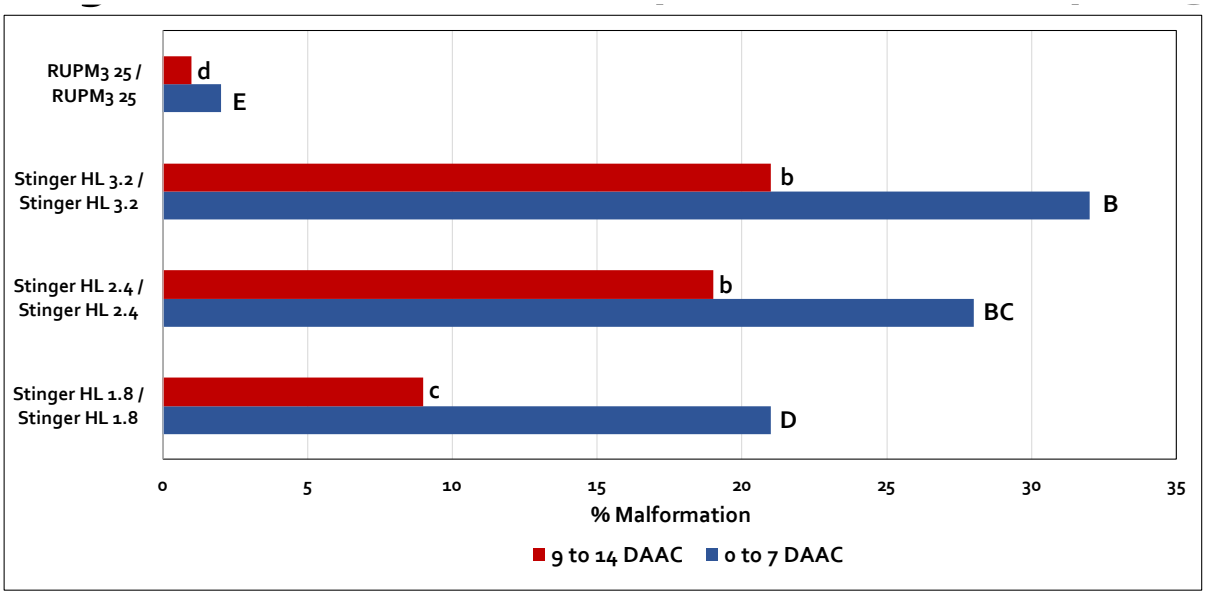

Figure 1. Visible malformation injury from Stinger HL mixed with Roundup PowerMax3, averaged across Crookston and Prinsburg, MN and Prosper, ND, 2025.

However, growth reduction injury was less than malformation injury.

Stinger HL and Roundup PowerMax3 mixed with Select Max or S-metolachlor, vegetative tolerance. Sugarbeet malformation and growth reduction injury increased with S-metolachlor was mixed with Stinger HL, Roundup PowerMax3 and ethofumesate (Table 2, Figure 2). Malformation injury was damage to the petioles and affected the ability of new sugarbeet leaves to unroll. Injury was less 9 to 14 DAAC but still was greater than 30%.

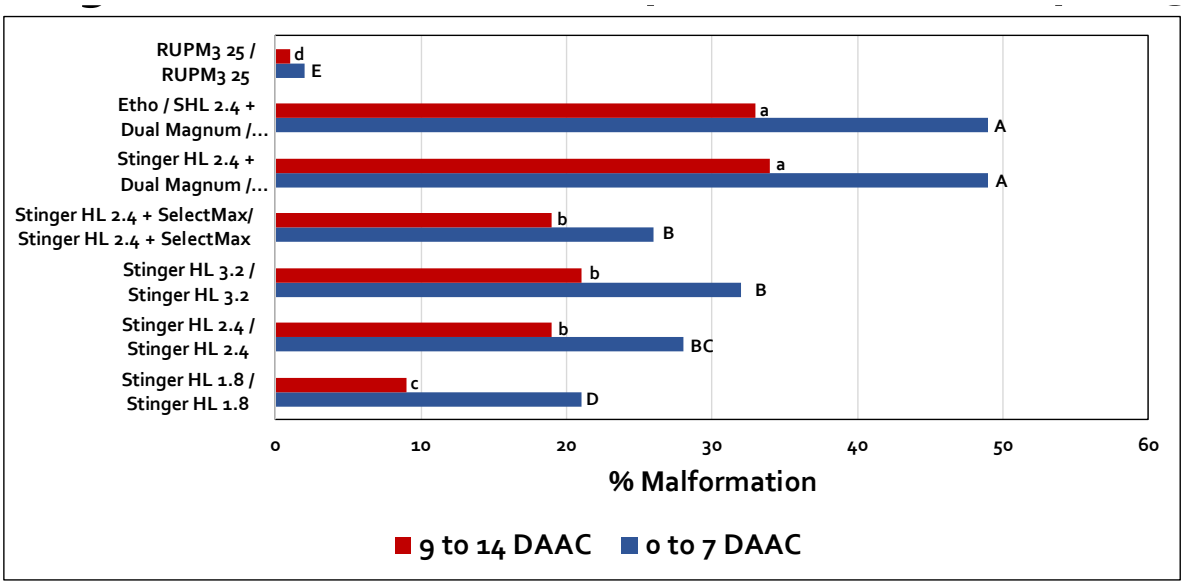

Figure 2. Visible malformation injury from Stinger HL and Roundup PowerMax3 alone or mixed with Select Max and *S*-metolachlor, averaged across Crookston and Prinsburg, MN and Prosper, ND, 2025.

Figure 3. Visible malformation injury captured June 11, 2025 or 16 DAAB and 1 DAAC, Prinsburg, MN. Image includes treatment number. Note degree of malformation damage in images 1 to 3 and 4 to 7. Image 7 is the Roundup PowerMax3 control.

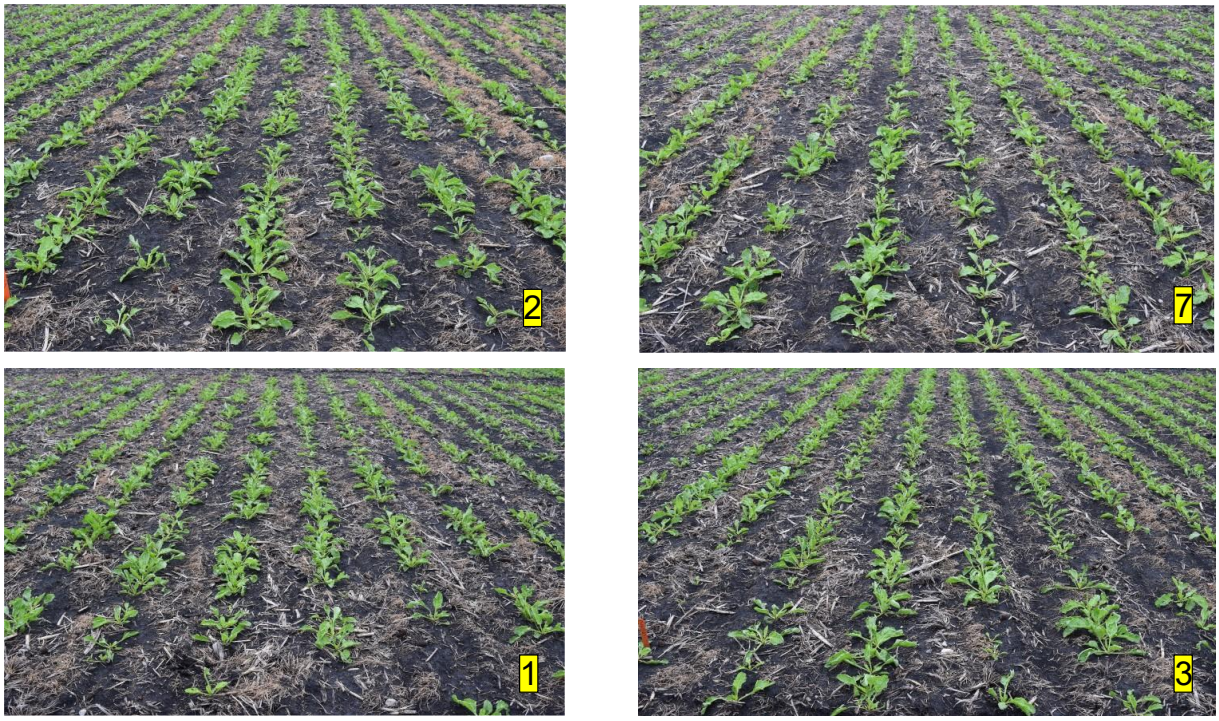

Figure 4. Growth reduction injury captured June 12, 2025 or 2 DAAC, Prinsburg, MN, 2025. Image includes treatment number.

Stinger HL mixed with Roundup PowerMax3, yield paramters. Sugarbeet root yield was not influenced by Stinger HL rate (Table 3). We did observe a numeric decrease in root yield as the Stinger HL rate increased from 2-times 1.8, 2.4 and 3.1 fl oz/A. However, the 2-times Stinger HL at 2.4 fl oz/A provided root yield numerically greater than the 2-times Roundup PowerMax3 control. We observed no statistical differences in sucrose content or recoverable sucrose per acre as the 2-times Stinger HL rate with Roundup PowerMax3 increased from 1.8 to 3.1 fl oz/A.

Stinger HL and Roundup PowerMax3 mixed with Select Max or S-metolachlor, yield parameters. Root yield and recoverable sucrose per acre were less when 2-times *S*-metolachlor was mixed with Stinger HL, Roundup PowerMax3 and ethofumesate (Table 3). *S*-metolachlor mixed with Stinger HL, Roundup PowerMax3 and ethofumesate also tended to reduce sucrose content. Select Max mixed with Stinger HL, Roundup PowerMax3 and ethofumesate did not reduce root yield or recoverable sucrose but reduced sucrose content.

Table 3. Sugarbeet stand and yield parameters in response to herbicide treatment, averaged across Crookston and Prinsburg, MN and Prosper, ND, 2025.[a]

Treatment	Rate	Sugarbeet Stand	Root Yield	Sucrose	Recoverable Sucrose
	fl oz/A	N/100 ft	Ton/A	%	lb/A
Stinger HL + RUPM3 / Stinger HL + RUPM3	1.8+25/1.8+25	46	28.3 a	15.96 ab	6739 a
Stinger HL + RUPM3 / Stinger HL + RUPM3	2.4+25/2.4+25	46	27.9 ab	15.98 a	6670 a
Stinger HL + RUPM3 / Stinger HL + RUPM3	3.2+25/3.2+25	47	27.0 ab	15.76abc	6724 a
Stinger HL + Select Max + RUPM3/ Stinger HL +Select Max + RUPM3	2.4+10+25/ 2.4+10+25	45	27.3 b	15.51 c	6322a
Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	2.4+16+6+25/ 2.4+16+6+25	48	26.1 c	15.68 bc	6081 c
Ethofumesate / Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	96/2.4+16+6+25/ 2.4+16+6+25	44	25.9 c	15.81abc	6006 c
RUPM3 + etho / RUPM3 + etho	25+6/25+6	48	27.4 ab	16.01 a	6646 ab
P-Value		0.8098	<0.0001	0.0108	<0.0001

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.05 alpha level.
[b]Stinger HL was mixed with Roundup PowerMax3 plus Prefer 90 NIS and Amsol liquid AMS at 0.25% v/v and 2.5% v/v. Stinger HL was mixed with Roundup PowerMax3 and Select Max with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v. Stinger HL, Roundup PowerMax3, S-metolachlor and ethofumesate were mixed with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

Brushvale, MN. We observed more variation at our Brushvale, MN location and elected not to include these data into the combined analysis. Ethofumesate followed by Stinger HL mixed with Roundup PoweMax3, ethofumesate and S-metolachlor tended to cause the most sugarbeet vegetative injury. We also observed more malformation than growth reduction injury with Stinger HL and Roundup PowerMax3 were mixed with Select Max.

Root yield and recoverable sucrose per acre tended to corelate to sugarbeet stand. Sucrose content did not appear to be related to herbicide treatment.

Table 4. Visible percent growth reduction and malformation in response to treatment, Brushvale, MN, 2025.[a]

Treatment[b]	Rate	Growth Reduction	Malforma-tion	Growth Reduction	Malforma-tion
	fl oz/A	----(1 DAAC)----		----(12 DAAC)----	
Stinger HL + RUPM3 / Stinger HL + RUPM3	1.8+25/1.8+25	5	5 b	8 bcd	18 b
Stinger HL + RUPM3 / Stinger HL + RUPM3	2.4+25/2.4+25	10	12 ab	13 abc	21 b
Stinger HL + RUPM3 / Stinger HL + RUPM3	3.2+25/3.2+25	3	13 ab	18 ab	34 a
Stinger HL + Select Max + RUPM3/ Stinger HL +Select Max + RUPM3	2.4+10+25/ 2.4+10+25	5	13 ab	3 cd	18 b
Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	2.4+16+6+25/ 2.4+16+6+25	8	7 b	4 cd	12 bc
Ethofumesate / Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	96/2.4+16+6+25/ 2.4+16+6+25	15	20 a	23 a	20 b
RUPM3 + etho / RUPM3 + etho	25+6/25+6	0	3 b	0 d	4 c
P-Value		0.1171	0.0412	0.0026	0.0006

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Stinger HL was mixed with Roundup PowerMax3 plus Prefer 90 NIS and Amsol liquid AMS at 0.25% v/v and 2.5% v/v. Stinger HL was mixed with Roundup PowerMax3 and Select Max with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v. Stinger HL, Roundup PowerMax3, S-metolachlor and ethofumesate were mixed with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

Table 5. Sugarbeet stand and yield parameters in response to herbicide treatment, Brushvale, ND, 2025.[a]

Treatment[b]	Rate	Sugarbeet Stand	Root Yield	Sucrose	Recoverable Sucrose
	fl oz/A	N/100 ft	Ton/A	%	lb/A
Stinger HL + RUPM3 / Stinger HL + RUPM3	1.8+25/1.8+25	24	23.7	16.3	4632
Stinger HL + RUPM3 / Stinger HL + RUPM3	2.4+25/2.4+25	21	21.1	16.2	3807
Stinger HL + RUPM3 / Stinger HL + RUPM3	3.2+25/3.2+25	20	20.1	16.6	3555
Stinger HL + Select Max + RUPM3/ Stinger HL +Select Max + RUPM3	2.4+10+25/ 2.4+10+25	25	25.2	16.5	5010
Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	2.4+16+6+25/ 2.4+16+6+25	23	23.2	16.7	4772
Ethofumesate / Stinger HL + *S*-metolachlor + etho + RUPM3/ Stinger HL + *S*-metolachlor + etho +RUPM3	96/2.4+16+6+25/ 2.4+16+6+25	23	23.2	16.2	4379
RUPM3 + etho / RUPM3 + etho	25+6/25+6	26	25.9	16.1	5151
LSD (0.10)		NS	NS	NS	NS

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.1 alpha level.
[b]Stinger HL was mixed with Roundup PowerMax3 plus Prefer 90 NIS and Amsol liquid AMS at 0.25% v/v and 2.5% v/v. Stinger HL was mixed with Roundup PowerMax3 and Select Max with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v. Stinger HL, Roundup PowerMax3, S-metolachlor and ethofumesate were mixed with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

Discussion

We observed malformation injury, especially following the repeat Stinger HL application. Malformation injury tended to increase with Stinger HL rate but was less 9 to 14 days after application. We did not observe loss of root yield, sucrose content or recoverable sucrose per acre. S-metolachlor mixed with Stinger HL, Roundup PowerMax3 and ethofumesate increased malformation injury as compared to Stinger HL, Roundup PowerMax3 and ethofumesate alone. We also measure less root yield and recoverable sucrose.

Does S-metolachlor increase malformation injury from Stinger HL, PowerMax3 and ethofumesate? We have previously reported that *S*-metolachlor mixed with Roundup PowerMax3 and ethofumesate, either alone or following ethofumesate and Dual Magnum PRE does not reduce root yield, sucrose content or recoverable sucrose per acre as compared to other treatments (Table 6). In greenhouse experiments we have observed that sugarbeet injury from Betamix and/or Lorsban are exacerbated by 'activators' such as a Stinger HL...under certain environmental conditions. Our first suggestion is to manage the adjuvants added to the spray tank. Injury might be related to the number and amount of formulated adjuvants in tank-mixtures. Second, we remind you that many of our tolerance experiments are conducted under trait neutral conditions and that these programs are effective in fields with weeds. All sugarbeet herbicides must be metabolized by sugarbeet. Metabolism is influenced by cool, wet and cloudy environmental conditions. We urge you to consider the conditions at application rather than compromising what is added to the spray tank.

Table 6. Yield parameters in response to herbicide treatments, multiple location yield experiment, 2021.[a]

Factor A PRE Herbicide	Factor B Postemergence Herbicide[b,c]	Root Yield	Sucrose	Recoverable Sucrose
		Ton/A	%	lb/A
No	glyphosate / glyphosate	37.9 a	15.9	10,415 a
No	*S*-metolachlor + etho / *S*-metolachlor + etho	36.0 a	15.8	10,033 a
PRE	glyphosate/glyphosate	37.9 a	15.7	10,215 a
PRE	*S*-metolachlor + etho / *S*-metolachlor + etho	36.9 a	15.7	10,133 a
P-Value		<0.0001	0.2402	<0.0001

[a]Means followed by the same alphabetical letter within columns are not significantly different at the 0.05 alpha level.
[b]Roundup PoweMax mixed with treatments.
[c]etho=ethofumesate.

COMMON RAGWEED CONTROL WITH SPIN-AID ALONE AND SPIN-AID MIXED WITH STINGER HL IN SUGARBEET

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Summary

1. A one-time Spin-Aid mixed with ethofumesate application does not provide acceptable common ragweed control.
2. A two-time Spin-Aid mixed with ethofumesate application controlled common ragweed better than a one-time Spin-Aid application, but did not consistently deliver greater than 90%, especially after 30 days.
3. Two-times Stinger HL applications mixed with Spin-Aid and ethofumesate may improve tough to control common ragweed populations or slightly larger common ragweed.
4. Two-times Spin-Aid mixed with Stinger HL is an opportunity for broad-spectrum control POST including common lambsquarters and glyphosate resistant kochia.

Introduction

Common ragweed (*Ambrosia artemisiifolia* L.) is a summer annual broadleaf weed that can cause devastating impacts in sugarbeet when left unmanaged (Figure 1). Common ragweed emerges earlier than most other summer annual weeds in eastern North Dakota and Minnesota, conferring an emergence advantage over its competitors including sugarbeet. Common ragweed's aggressive growth habit can reduce crop yield by 38% in corn (*Zea mays* L.) and 95% in soybean [*Glycine max* (L.) Merr.] (Barnes et al. 2018). Common ragweed is a prolific seed producer; a single plant can produce up to 62,000 seeds, and seeds remain viable for 39 years (Baskin and Baskin 1980; Dickerson and Sweet 1971). Common ragweed's propensity to evolve resistance to commonly used herbicides in the cropping sequence further exacerbates control challenges. Further, common ragweed populations have been documented to have evolved resistance to five herbicide sites of action (SOA, WSSA group number) including: photosystem II (PSII, 5), acetolactate synthase inhibitors (ALS, 2), protoporphyrinogen oxidase inhibitors (PPO, 14), 5-enolpyruvoylshikimate 3-phosphate synthase inhibitors (EPSPS, 9), and auxin mimics inhibitors (4) (Heap 2025).

Clopyralid [trade name Stinger, Stinger HL, Clean Slate, Spur (I will refer to it as Stinger HL)] is an auxin mimics (Group 4) herbicide commonly used in sugarbeet in eastern North Dakota and Minnesota. Its broadleaf spectrum is unique from that of other auxin mimics, being especially effective in controlling common ragweed but having less/no activity on other critical broadleaf weed species in sugarbeet including common lambsquarters [*Chenopodium album* L.]) kochia [*Bassica scoparia* (L.) A.J.Scott] and waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer]. There is evidence of certain common ragweed populations tolerating higher doses of clopyralid. Further, Stinger HL use rates are not according to label; growers familiar with the micro-rate programs historically used less and there are concerns about carryover to drybean (*Phaseolus vulgaris* L.) and corn. Finally, common ragweed less than 2-inch in diameter should be targeted for control. Growers often delay application since glyphosate (trade name Roundup PowerMax3) applied with clopyralid will kill the grass companion crop.

Phenmedipham (trade name Spin-Aid) is a group 5 herbicide marketed by Belchim USA for control of common ragweed, common lambsquarters, and kochia in sugarbeet. Two-times Spin-Aid alone or mixed with Stinger HL potentially could reduce the specter of common ragweed resistance and improve/lengthen common ragweed control in sugarbeet. Phenmedipham mixed with clopyralid also would enable application timing to optimize common ragweed control without damaging companion grass crops. The objectives of this project are a) to determine common ragweed control from 1-time or 2-times Spin-Aid with ethofumesate application; and b) to determine if Spin-Aid mixed with Stinger HL improves common ragweed control from Stinger HL alone under field conditions.

Figure 1. Common ragweed in sugarbeet, Traill County, ND, 2024

Materials and Methods

General. Experiments were conducted near Hillsboro ND and Shelly MN in 2025. The experimental area at each location was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was the previous crop at both locations. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.5 inch spacing between seeds on April 24 at Hillsboro and May 8 at Shelly. We elected to replant the Hillsboro experiments on May 19 due to crusting issues from a significant rain event 4 days after planting. Treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO2 approximately 40 psi to the center four rows of six row plots 40 feet in length.

Spin-Aid. Common ragweed experiments with one or two-times Spin-Aid mixed with ethofumesate application were conducted near Hillsboro ND and Shelly MN in 2025. Spin-Aid and ethofumesate were mixed with Roundup PowerMax3 with the second application. Treatments are in Table 1.

Sugarbeet growth reduction injury and common ragweed control was evaluated approximately 7, 21 and 28 days after the repeat Spin-Aid mixed with ethofumesate application (DAAC) using a 0 to 99% scale (0% denoting no sugarbeet injury or common ragweed control and 99% denoting complete loss of sugarbeet stature/stand or common ragweed 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 2025.5 software package.

Spin-Aid and Stinger HL alone and Spin-Aid mixed with Stinger HL. Common ragweed experiments with one or two-times Spin-Aid with ethofumesate alone or mixed with Stinger HL application were conducted near Hillsboro ND and Shelly MN in 2025. Treatments are in Table 2.

Sugarbeet growth reduction injury and common ragweed control was evaluated approximately 7, 14, 21 and 28 days after the second POST application (DAAC) using a 0 to 99% scale (0% denoting no sugarbeet injury or common ragweed control and 99% denoting complete loss of sugarbeet stature/stand or common ragweed control). This report contains evaluations approximately 7 and 21 DAAC. All evaluations were a visible estimate of injury or

Table 1. Herbicide treatments, herbicide rates and application timing.

Num	Herbicide treatment[a,b]	Rate	Sugarbeet stage
		(fl oz)	(lf stage)
1	Spin-Aid + ethofumesate	16 + 4	2
2	Spin-Aid + ethofumesate	24 + 4	2
3	Spin-Aid + ethofumesate	32 + 4	2
4	Spin-Aid + ethofumesate	40 + 4	2
5	SA + etho / SA + etho + RUPM3	20 + 4 / 28 + 4 + 25	2 / 5-7d
6	SA + etho / SA + etho + RUPM3	28 + 4 / 32 + 4 + 25	2 / 5-7d
7	SA + etho / SA + etho + RUPM3	32 + 4 / 40 + 4 + 25	2 / 5-7d
8	Etho / SA + etho	6 / 28 + 4	PRE / 2
9	Etho / SA + etho / SA + etho + RUPM3	6 / 28 + 4 / 32 + 4 + 25	PRE / 2 / 5-7d

[a]Mix Spin-Aid and ethofumesate with HSMOC at 1 pt/A. Roundup PowerMax3, Spin-Aid and ethofumesate with HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v
[a]abbreviations: SA=Spin-Aid; etho=ethofumesate; RUPM3=Roundup PowerMax3

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 2025.5 software package.

Table 2. Herbicide treatments, herbicide rates and application timing.

Num	Postemergence Herbicide[a,b,c]	Rate	Sugarbeet stage	Common ragweed stage
		(fl oz/A)	(lf stage)	(lf stage or inch)
1	Spin-Aid	28	2-4 lf	2 in
2	Spin-Aid / Spin-Aid	28 / 32	2-4 lf / 5-7 d	2 in / 5-7 day
3	Stinger HL	1.8	2-4 lf	2 in
4	Stinger HL / Stinger HL	1.8 / 1.8	2-4 lf / 5-7 d	2 in / 5-7 day
5	Spin-Aid + Stinger HL	28 + 1.8	2-4 lf	2 in
6	Spin-Aid + Stinger HL / SA + SHL	28 + 1.8 / 28 + 1.8	2-4 lf / 5-7 d	2 in / 5-7 day
7	Spin-Aid + Stinger HL + RUPM3	28 + 1.8 + 25	2-4 lf	2 in
8	SA + SHL / SA + SHL +RUPM3	28 + 1.8 / 28 + 1.8 + 25	2-4 lf / 5-7 day	2 in / 5-7 day
9	Etho / SA + Stinger HL	6 / 28 + 1.8	PRE/ 2-4 lf	PRE/ 2 in

[a]Ethofumesate at 4 fl oz/A mixed with Spin-Aid
[b]Spin-Aid mixed with ethofumesate, 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
[c]abbreviations: SA=Spin-Aid; SHL=Stinger HL; RUPM3=Roundup PowerMax3

Results

Spin-Aid. Sugarbeet injury was negligible at both the Hillsboro and Shelly experiments (data not presented). However, visible growth reduction injury tended to be greater from 2-times Spin-Aid mixed with ethofumesate application as compared to a single dose at Shelly. A derecho with wind speeds estimated between 60 to over 100 mph for a 2 to 3-hour period on June 20, 2025 compromised sugarbeet injury evaluation at Hillsboro.

We observed much greater common ragweed emergence at Hillsboro than Shelly. Average common ragweed control across treatments 26 DAAC was 31% at Hillsboro and 69% at Shelly. One-time Spin-Aid mixed with ethofumesate application did not provide acceptable common ragweed control (Table 3). Common ragweed was less than 2-inch in diameter at Hillsboro and Shelly at application. Spin-Aid with ethofumesate at 32 and 40 fl oz per acre provided better control than Spin-Aid mixed with ethofumesate at 16 or 24 fl oz per acre at Shelly. We didn't observe a response to Spin-Aid mixed with ethofumesate rate at Hillsboro, presumably because of the strong common ragweed pressure and the continued emergence during the course of the experiment.

Two-times Spin-Aid mixed with ethofumesate, the second application with Roundup PowerMax3 improved common ragweed control at Hillsboro and Shelly (Table 2). We didn't observe a response to rate with the 2-times

Table 3. Visible percent common ragweed control in response to herbicide treatment, 8 to 12 and 26 days after the 2-times Spin-Aid plus ethofumesate treatment, Hillsboro, ND and Shelly, MN, 2025.[a]

Herbicide treatment[b]	Rate	Hillsboro, ND		Shelly, MN	
	(fl oz)	12 DAAC	26 DAAC	8 DAAC	26 DAAC
Spin-Aid + ethofumesate	16 + 4	10 d	10 cd	61 d	31 e
Spin-Aid + ethofumesate	24 + 4	21 cd	3 d	54 d	39 e
Spin-Aid + ethofumesate	32 + 4	28 c	15 bc	74 c	55 d
Spin-Aid + ethofumesate	40 + 4	29 c	25 b	74 c	50 d
SA + etho / SA + etho + RUPM3	20 + 4 / 28 + 4 + 25	79 a	71 a	94 a	84 b
SA + etho / SA + etho + RUPM3	28 + 4 / 32 + 4 + 25	78 a	66 a	95 a	87 ab
SA + etho / SA + etho + RUPM3	32 + 4 / 40 + 4 + 25	79 a	70 a	97 a	93 ab
Etho / SA + etho	6 / 28 + 4	46 b	18 bc	82 b	66 c
Etho / SA + etho / SA + etho + RUPM3	6 / 28 + 4 / 32 + 4 + 25	79 a	68 a	97 a	97 a
LSD (0.10)		16	12	9	11

[a]Common ragweed control followed by the same alphabetical letter indicates non-statistical differences between treatments at the 0.10 alpha level
[b]Spin-Aid and ethofumesate plus HSMOC at 1 pt/A. Spin-Aid and ethofumesate mixed with Roundup PowerMax3, Spin-Aid, and ethofumesate plus HSMOC at 1 pt/A and Amsol liquid AMS at 2.5% v/v.

Spin-Aid mixed with ethofumesate applications at either the Hillsboro or Shelly experiments. Ethofumesate PRE followed by 1-time Spin-Aid mixed with ethofumesate application improved common ragweed control as compared to Spin-Aid mixed with ethofumesate alone. However, ethofumesate PRE followed by 2-times Spin-Aid mixed with ethofumesate application delivered similar common ragweed control.

Spin-Aid and Stinger HL alone and Spin-Aid mixed with Stinger HL. We observed sugarbeet injury 8 and 20 DAAC at Shelly (data not presented). Five plots (out of 8 total) from 2-times Spin-Aid plus Stinger HL treatments (two separate treatments) scored 30% or greater sugarbeet injury. Three plots from a third 2-times Stinger HL treatment scored 30% or greater sugarbeet injury. Sugarbeet injury was not collected at Hillsboro. A derecho with wind speeds estimated between 60 to over 100 mph for a 2 to 3-hour period on June 20, 2025 compromised sugarbeet injury evaluation at Hillsboro.

Common ragweed infestation was heavy at Hillsboro and were continuing to emerge during the experiment. We may have waited a little too long with application as the largest common ragweed were 4-inch in diameter. Common ragweed density was moderate at Shelly and were approaching 3-inch in diameter. We targeted slightly larger than normal common ragweed since the experiment were mixtures of two products applied 1- and 2-times.

Two-time Spin-Aid mixed with ethofumesate improved common ragweed control as compared to 1-time Spin-Aid with ethofumesate application at Shell and Hillsboro. However, we did not realize effective common ragweed control (greater than 90% control) in either experiment. Two-times Stinger HL application provided 91% control 20 DAAC at Shelly.

Mixing Spin-Aid with ethofumesate and Stinger HL did not improve common ragweed as compared to Stinger HL alone with either experiment. However, mixing Roundup PowerMax3 with Stinger HL, Spin-Aid and ethofumesate improved common ragweed control at Hillsboro. Common ragweed control was best with 2-times Spin-Aid mixed with ethofumesate and Stinger HL. Mixing Stinger HL with Spin-Aid and ethofumesate improved common ragweed control as compared to 2-times Spin-Aid with ethofumesate or Stinger HL alone at Hillsboro. At Shelly, 2-times Spin-Aid with ethofumesate and Stinger HL controlled common ragweed similarly to 2-times Stinger HL alone. Mixing Roundup PowerMax3 with 2-times Stinger HL and Spin-Aid with ethofumesate did not further improve common ragweed control at either location.

We observed benefit from ethofumesate PRE for common ragweed control at Hillsboro where we observed continuous common ragweed emergence during the experiment.

Table 4. Visible percent common ragweed control in response to herbicide treatment, 6 to 8 and 20 days after Spin-Aid, Stinger Hl and Spin-Aid plus Stinger HL treatment, Hillsboro, ND and Shelly, MN, 2025.[a]

Herbicide treatment[b,c]	Rate	Hillsboro, ND		Shelly, MN	
	(fl oz)	6 DAAC	20 DAAC	8 DAAC	20 DAAC
Spin-Aid	28	28 g	5 f	71 c	46 d
Spin-Aid / Spin-Aid	28 / 32	66 b	43 e	87 b	78 c
Stinger HL	1.8	40 ef	65 c	80 bc	79 c
Stinger HL / Stinger HL	1.8 / 1.8	50 de	74 b	88 b	91 ab
Spin-Aid + Stinger HL	28 + 1.8	38 fg	44 e	83 b	84 bc
Spin-Aid + Stinger HL / SA + SHL	28 + 1.8 / 28 + 1.8	83 a	89 a	90 a	98 a
Spin-Aid + Stinger HL + RUPM3	28 + 1.8 + 25	64 bc	65 c	86 b	79 c
SA + SHL / SA + SHL + RUPM3	28 + 1.8 / 28 + 1.8 + 25	80 a	88 a	99 a	98 a
Etho / SA + Stinger HL	6 / 28 + 1.8	55 cd	56 d	86 b	83 bc
LSD (0.10)		11	8	10	11

[a]Common ragweed control followed by the same alphabetical letter indicates non-statistical differences between treatments at the 0.10 alpha level
[b]ethofumesate at 4 fl oz per acre was mixed with Spin-Aid
[c]Spin-Aid with ethofumesate plus HSMOC at 1 pt/A. Stinger HL plus HSMOC at 1 pt/A. Spin-Aid and ethofumesate mixed with Stinger HL plus HSMOC at 1 pt/A. Stinger HL or Spin-Aid and Stinger HL mixed with Roundup PowerMax3 plus HSMOC at 1pt/A and Amsol liquid AMS at 2.5% v/v.

Discussion

Our locations were complimentary. Our Hillsboro experiment was a commercial sugarbeet field in 2024. The common ragweed infestation was so strong that our grower cooperator elected not to harvest the field. Our Hillsboro experiments had a heavy common ragweed population with continuous common ragweed emergence in May and June. Our Shelly location was sugarbeet in 2024 and was a moderate common ragweed population with generally one late May emergence flush.

Spin-Aid mixed with ethofumesate must be a 2-times application for common ragweed control. Our research suggests Spin-Aid at 28 fl oz per acre followed by Spin-Aid at 32 fl oz per with the second application. A Spin-Aid tolerance and yield experiment conducted in 2024 (Peters and Aberle, Sgbt Res and Ext Rept., 55:25-32) indicated acceptable sugarbeet vegetative and yield tolerance with these treatments. However, the lack of consistency is concerning and is consistent with experiments conducted in 2024.

Mixing Stinger HL with Spin-Aid and ethofumesate does not replace a second application. These data were not conclusive as to if 2-times Stinger HL with Spin-Aid and ethofumesate provides common ragweed control greater than Stinger HL alone. We observed improved control at Hillsboro with a heavy common ragweed population but similar control at Shelly with a moderate common ragweed population. Spin-Aid with ethofumesate mixed with Stinger HL clearly is a strategy to use when one wishes to forgo glyphosate application and delay the termination of grassy companion crops. Mixing Stinger HL and Spin-Aid is also a chance to control other broadleaf weeds including common lambsquarters and glyphosate resistant kochia.

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ADUVANT KOCHIA CONTROL

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Summary
1. Ideal adjuvant selection based on active ingredients, tank mixtures, and weed-resistance history.
2. Kochia control is greatest when glyphosate is mixed with Spin-Aid and tallow amine adjuvants.

Introduction
Glyphosate resistant (GR) kochia has established in sugarbeet fields across the Red River Valley, adding to the complexity of weed control in sugarbeet. Many growers have responded by using maximum labeled rates of Roundup PowerMax3 in combination with adjuvant systems containing ethoxylated tallow amine (ETA). ETA-based adjuvants were integral to early glyphosate formulations and were widely regarded for superior herbicide uptake and performance. Results from 2024 greenhouse trials suggested that ETA–based adjuvants, such as Last Chance® Pro (CHS Inc., Inver Grove Heights, Minnesota) (5-15% tallow amine) improved kochia control compared with nonionic surfactants (NIS). However, field performance has been inconsistent, likely due to variability in tallow amine concentration, formulation differences, and interactions within tank mixtures. Products such as Full Load™ (AgraSyst, Inc. Spokane, WA) (40% tallow amine) and Fulltec (spraytec, Urbandale, IA) (carboxylic acid– and chelation-based conditioning system) provided informative comparisons of ETA vs. ETA, Fatty Alcohol Ethoxylate (FAE), NIS, and High Surfactant Methylated Oil Concentrate (HSMOC). This experiment was conducted to compare kochia control from Roundup PowerMax3 applied alone or in combination with Spin-Aid and several commercial adjuvants under field conditions. Our objective was to determine which adjuvant system provide the most consistent kochia control from glyphosate mixed with ethofumesate treatments.

Materials and Methods
A field experiment was conducted near Felton, MN in a sugarbeet field in 2025. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre and 4.5 inch spacing between seeds. Treatments were applied with a bicycle sprayer in 17 gallons per acre (GPA) spray solution through 8002 XR flat fan nozzles pressurized with CO2 at 35 psi to the center four rows of six row plots 40 feet in length when kochia was approximately 2-inch. (Table 1). Experiment was a randomized complete block design and 4 replications. Visible kochia control (0% to 99%, 0% indicating no control and 99 indicating complete control) were evaluated approximately 4, 7, and 14 days after application B (second POST application). Data were analyzed with the ANOVA procedure of ARM software package.

Table 1. Adjuvant treatments for kochia control field trial, Felton, MN, 2025.

Num	Treatment[a]	Rate
		(fl oz/A or %v/v)
1	Roundup PowerMax3 (RUPM3) + Prefer 90 / RUPM3 + Prefer 90	25 + 0.5% / 25 + 0.5%
2	RUPM3 + Level Best Pro (LBP) / RUPM3 + LBP	25 + 0.5% / 25 + 0.5%
3	RUPM3 + Full Load /RUPM3 + Full Load	25 + 0.5% / 25 + 0.5%
4	RUPM3 + Fulltec / RUPM3 + Fulltec	25 + 0.5% / 25 + 0.5%
5	RUPM3 + Spin-Aid (SA) + Prefer 90 / RUPM3 + SA + Prefer 90	25 + 28 + 0.5% / 25 + 32 + 0.5%
6	RUPM3 + SA + LBP / RUPM3 + SA + LBP	25 + 28 + 0.5% / 25 + 32 + 0.5%
7	RUPM3 + SA + Full Load / RUPM3 + SA + Full Load	25 + 28 + 0.5% / 25 + 32 + 0.5%
8	RUPM3 + SA + Fulltec / RUPM3 + SA + Fulltec	25 + 28 + 0.5% / 25 + 32 + 0.5%

[a]Ethofumesate at 6 fl oz/A and Amsol liquid AMS at 2.5% v/v with all treatments.

Growing Conditions in the Field
Kochia emergence occurred from mid-April through June and was favored by intermittent cooling periods and timely rainfall (Figure 1). Early-emerging kochia remained between 0.5 and 3 inches tall until mid-May, consistent with below-normal temperatures and periodic cooling events reported by NDAWN during this period. Despite limited growth in April and May, successive emergence flushes resulted in high overall weed pressure at the Felton, MN site in 2025 (Figures 2 and 3). At application A (May 14), kochia averaged four side shoots and approximately

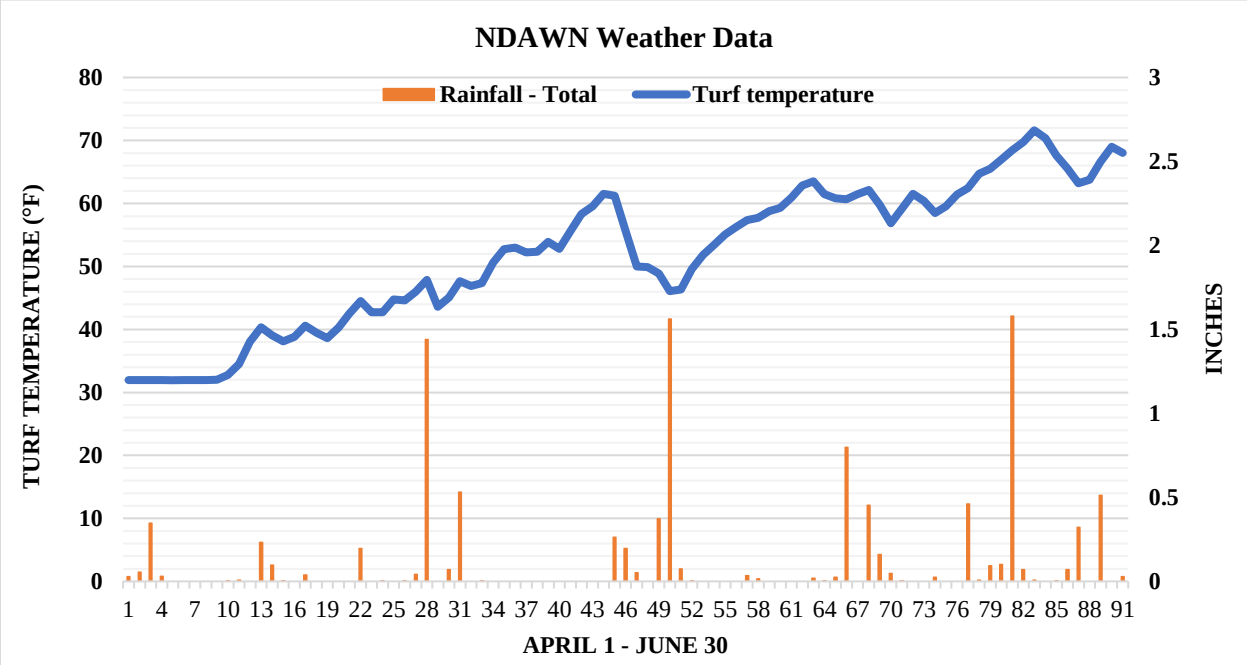

Figure 1. Soil covered with grasses temperature and rainfall at Felton, MN, 2025.

three inches in height. By application B (May 22), plants had increased to an average of six side shoots while remaining near three inches tall. Kochia measuring approximately three inches tall with multiple lateral shoots at both application timings represents a challenging growth stage for glyphosate control, as increased biomass with multiple growing points reduce translocation of active ingredients to meristematic tissues, thereby diminishing overall phytotoxic efficacy; moreover, kochia greater than 2 inches tall with multiple growing points readily metabolize and detoxify xenophobic compounds quickly compared to small kochia (Soltani et al. 2016).

Greenhouse

Greenhouse experiments were conducted using a glyphosate tolerant kochia seed source collected at North Dakota State University (NDSU) field research facilities. Kochia was grown in a flat filled with PROMIX general purpose greenhouse media (Premier Horticulture, Inc., Quakertown, PA) to 0.25-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® 8001 even banding nozzle (TeeJet Technologies, Glendale Heights, IL) calibrated to deliver 15 GPA spray solution at 31 psi and 2 mph when kochia was approximately at the 5-lf or 'dime' size in diameter. Herbicide treatments follow (Table 2). Visible kochia control (0% to 99%, 0% indicating no control and 99 indicating complete control) were evaluated approximately 6 and 9 days after treatment (DAT). Experiment was a randomized

Table 2. Kochia control with adjuvants, NDSU Waldron Greenhouse, 2025.[a]

Treatments	Rates
	(fl oz/A and %v/v)
Roundup PowerMax3 + Nortron + Destiny HC[b]	25 + 4 + 0.5%
RUPM3 + Nortron + Last Chance Pro	25 + 4 + 0.5%
RUPM3 + Nortron + Full Load	25 + 4 + 0.25%
RUPM3 + Nortron + Fulltec	25 + 4 + 18
RUPM3 + Nortron + Spin-Aid + Destiny HC	25 + 4 + 24 + 0.5%
RUPM3 + Nortron + Spin-Aid + Last Chance Pro	25 + 4 + 24 + 0.5%
RUPM3 + Nortron + Spin-Aid + Full Load	25 + 4 + 24 + 0.25%
RUPM3 + Nortron + Spin-Aid + Fulltec	25 + 4 + 24 + 18
Untreated Check	

complete block design and 4 reps. Experiments were analyzed using Agricultural Research Manager (ARM) version 2025.5.

Field Results

Kochia control was influenced by adjuvant treatment at Felton (Table 3, Figures 1 and 2). At 4 DAAB (days after application B, treatments with Spin-Aid tended to increase kochia control as compared with Roundup PowerMax3 alone with adjuvants. Kochia control numerically was greatest when Spin-Aid and Roundup PowerMax3 were combined with Last Chance Pro (93%), Full Load (91%) or Fulltec (90%). Full Load mixed with Roundup PowerMax3 provided kochia control greater (81%) than Prefer 90 (63%) or Fulltec (58%). Kochia control from Spin-Aid mixed with Roundup PowerMax3 and adjuvants continued to provide greater control than Roundup PowerMax3 alone with adjuvants, 18 DAAB. Last Chance Pro, Full Load and Fulltec mixed with Roundup PowerMax3 and Spin-Aid tended to provide kochia control greater than Prefer 90 mixed with Roundup PowerMax3 and Spin-Aid. Roundup PowerMax3 mixed with Last Chance Pro, Full Load or Prefer 90 provided similar kochia control but control less than Spin-Aid mixed with RoundupPowerMax3 and adjuvants.

Table 3. Kochia control with adjuvants, Felton, MN 2025.[a]

Treatments	4 DAAB	11 DAAB	18 DAAB[c]
	----------%----------		
Roundup PowerMax3 + Nortron + Prefer 90[b]	63 c	78	79 c
Roundup PowerMax3 + Nortron + Last Chance Pro	70 bc	83	80 bc
Roundup PowerMax3 + Nortron + Full Load	81 ab	80	80 bc
Roundup PowerMax3 + Nortron + Fulltec	58 c	75	70 d
Roundup PowerMax3 + Nortron + Spin-Aid + Prefer 90	84 ab	88	85 abc
Roundup PowerMax3 + Nortron + Spin-Aid + Last Chance Pro	93 a	93	91 a
Roundup PowerMax3 + Nortron + Spin-Aid + Full Load	91 ab	89	90 a
Roundup PowerMax3 + Nortron + Spin-Aid + Fulltec	90 a	86	88 ab
LSD (0.05)	15	NS	6
P-Value	0.0001	0.1263	0.0001

[a]Means within evaluation columns not sharing a letter are significantly different according to Fisher's protected LSD at α=0.05.
[b]Treatments repeated 10 days after application A.
[c]Days after application B or application approximately at the 2-lf sugarbeet stage

Figure 2. Spin-Aid mixed with Roundup PowerMax3 and Prefer 90 NIS and Amsol liquid AMS, 18 DAAB, Felton, MN, June 9, 2025.

Figure 3. Roundup PowerMax3 mixed with Prefer 90 NIS and Amsol liquid AMS, 18 DAAB, Felton, MN, June 9, 2025.

Greenhouse Results. Spin-Aid mixed with Roundup PowerMax3 and adjuvants tended to improve kochia control from Roundup PowerMax3 with adjuvants (Table 4, Figures 4 and 5). Kochia control from Roundup PowerMax3 alone or Roundup PowerMax3 with Spin-Aid was influenced by adjuvants. Roundup PowerMax3 mixed with Last Chance Pro provided kochia control greater than all other adjuvant combinations, 6 and 9 days after treatment (DAT). Mixing Spin-Aid with Roundup PowerMax3 generally improved performance across adjuvant types. Fulltec consistently provided the least kochia control with or without Roundup PowerMax3.

Table 4. Kochia control with adjuvants, NDSU Waldron Greenhouse, 2025.[a]

Num	Treatments	6 DAT	9 DAT[b]
		----------%----------	
1	Roundup PowerMax3 (RUPM3) + Nortron + Destiny HC	28 bc	53 c
2	RUPM3 + Nortron + Last Chance Pro	73 a	91 a
3	RUPM3 + Nortron + Full Load	34 bc	65 abc
4	RUPM3 + Nortron + Fulltec	5 c	10 d
5	RUPM3 + Nortron + Spin-Aid + Destiny HC	56 ab	81 ab
6	RUPM3 + Nortron + Spin-Aid + Last Chance Pro	61 ab	86 ab
7	RUPM3 + Nortron + Spin-Aid + Full Load	61 ab	85 ab
8	RUPM3 + Nortron + Spin-Aid + Fulltec	54 ab	65 abc
9	Untreated Check	0 c	0 d
	P-Value	0.0001	0.0001

[a]Means within evaluation columns not sharing a letter are significantly different according to Fisher's protected LSD at α=0.05.
[b]Days after treatment.

Figure 4. From left to right, kochia control from treatments 1, 2, 3, and 4, Roundup PowerMax3 with adjuvants, 14 days after treatment (14 DAT), Waldron greenhouse, 2025.

Figure 5. From left to right, kochia control from treatments 5, 6, 7, and 8, Roundup PowerMax3 mixed with Spin-Aid, 14 DAT, Waldron greenhouse, 2025.

Discussion.

Field and greenhouse experiments indicate ETA-based adjuvants with Roundup PowerMax3 improved kochia control as compared to Roundup PowerMax3 mixed with NIS, HSMOC, and FAE-based adjuvant systems. However, it is important to distinguish unique capabilities of each adjuvant system and how this influenced results. Differences in kochia control among adjuvant systems reflect fundamental differences in surfactant chemistry and formulation interactions. Ethoxylated tallow amines possess cationic, lipophilic properties that enhance cuticular penetration and plant mobility, increasing glyphosate uptake and translocation. Conversely, NIS and FAE primarily improve spray retention and spreading, resulting in less aggressive penetration and more variable efficacy. High surfactant methylated oil concentrates like Destiny HC enhance cuticle solubilization by "loosening" nonpolar cuticular waxes, thereby increasing cuticle permeability for polar herbicide molecules like glyphosate or glufosinate. In our experiments, Destiny HC with Roundup PowerMax3 (53%) provide less kochia control as compared to ETA product Last Chance Pro (91%) with PowerMax3 alone, but provided similar kochia control when Full Load was mixed with Spin-Aid and Roundup PowerMax3 suggesting these two adjuvant systems have effective carrier capabilities while Last Chance Pro increases glyphosate efficacy alone or in tank mixtures.

Fulltec contains 27.8% phosphoric acid, acting as a water conditioning agent like that of ammonium sulfate (AMS). However, poor kochia control from Fulltec treatments was evaluated. One possible explanation, Fulltec is not a cationic adjuvant, unlike products such as Full Load or Last Chance Pro. The absence of a cationic surfactant may have reduced glyphosate absorption and subsequent translocation to meristematic binding sites in a highly glyphosate-tolerant kochia population. Additionally, Fulltec has a viscous formulation that may have separated since May, 2025, and required further mixing before measuring Waldron Greenhouse treatments in November, 2025.

Fatty alcohol ethoxylate, Fulltec, is most important in complex tank mixtures since the nonionic reduces the potential for cation exchange and chelation among formulation types and active ingredients. Conditioning products like Fulltec are advantageous when hard water, multivalent ions, or multiple formulation chemistries are present, as chelation and pH buffering can preserve herbicide availability and spray solution stability. This effect was demonstrated when Roundup PowerMax3 was mixed with Spin-Aid, where improved compatibility and performance suggested enhanced glyphosate activity through cation chelation and pH stabilization (Table 4). In the absence of effective conditioning, these interactions may limit uptake of weak acid herbicides such as dicamba or 2,4-D.

Summary

Differences among adjuvant systems demonstrated relative strengths in controlling glyphosate tolerant kochia (Figure 6). Cationic ETA-based adjuvants consistently provided the most reliable control, particularly when tank-mixed with Spin-Aid, because their cationic and lipophilic properties enhance cuticle penetration, translocating movement, and spray retention. Nonionic systems like fatty alcohol ethoxylates improved spray coverage and spreading but generally provided less uptake and translocation. These results illustrate how adjuvant chemistry affects herbicide performance and highlight the potential of ETA and other adjuvant systems to improve control of non-target-site-resistant kochia. Finally, AMS was included in the 2025 field trial but not in the greenhouse trial. Adjuvant systems, ETA and FAE, contain sulfuric or phosphoric acid that acts like AMS by adjusting spray solution pH, further supporting herbicide activity.

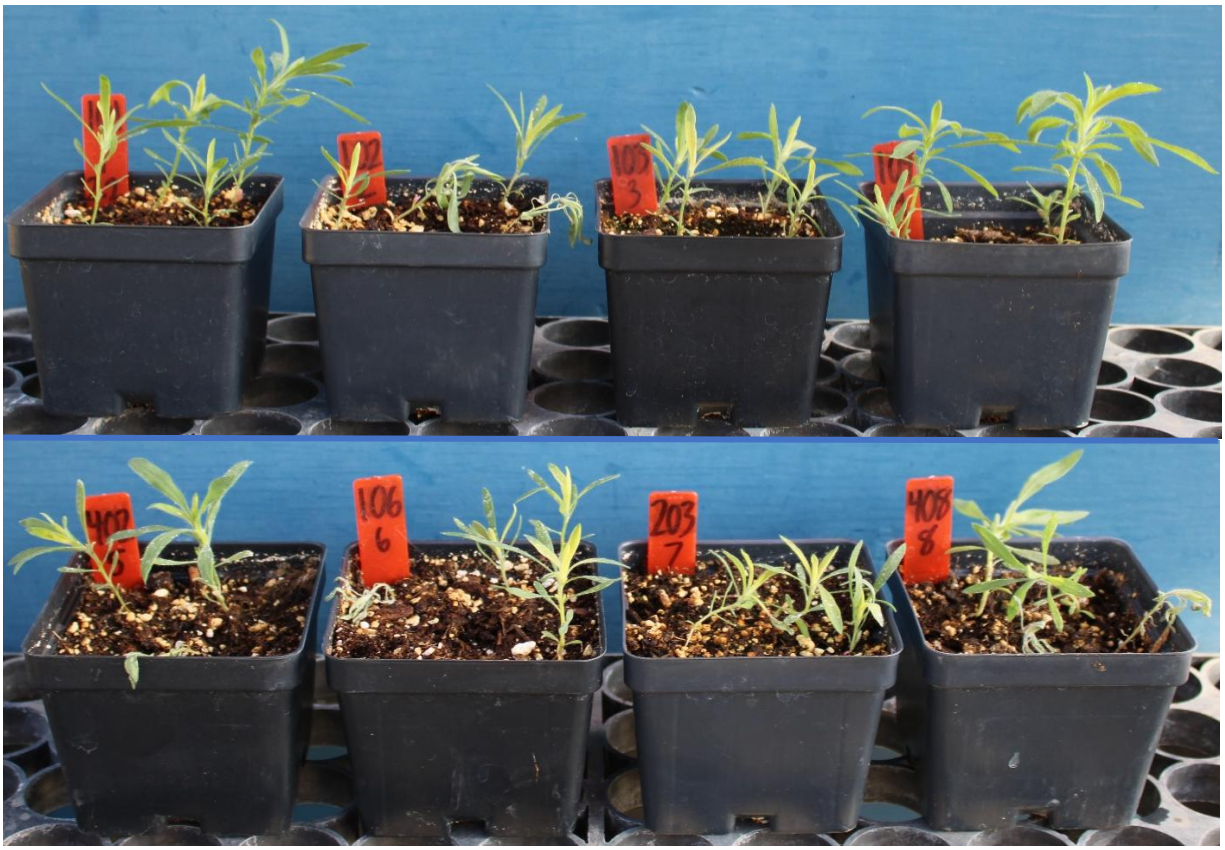

Figure 6. Kochia control 10 DAAA, Waldron Greenhouse, 2025.

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REVISITING ANTOR FOR WATERHEMP CONTROL

Thomas J. Peters[1], Adam D. Aberle[2] and [3]Clark Alder

[1]Extension Sugarbeet Agronomist, [2]Research Specialist, North Dakota State University & University of Minnesota, Fargo, ND, and [3]Clark Alder, KWS Seeds, Middleton, ID

Summary

1. Sugarbeet injury was negligible from Antor at 3 and 6 quart per acre.
2. Antor at 6 qt/A provided waterhemp control greater than Antor at 3 qt/A.
3. We observed similar waterhemp control from Antor at 6 qt/A and Nortron (ethofumesate) at 6 pt/A.

Introduction

I have made it a point during my tenure to evaluate every possible active for efficacy on waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer]. Glyphosate resistant waterhemp was identified by sugarbeet growers attending the 2025 grower seminars as the most troublesome weed for control in sugarbeet production weed control in Minnesota and North Dakota; reported on 451,888 acres or 71% of acreage according to 2025 survey. Further, waterhemp was identified as most troublesome weed at every grower seminar, seminars ranging from Willmar in west central Minnesota to Grafton in the northern Red River Valley.

Antor® herbicide, active ingredient diethatyl-ethyl was a α-chloroacetamide class herbicide which inhibits very long-chain fatty acid synthesis (VLCFA) in susceptible plants. Antor was developed by NOR-AM Chemical Company for control of annual grasses and selective broadleaf weeds in a number of crops including sugarbeet. Antor was approved for use in sugarbeet in February 1982, but its registration was cancelled in April 1993. Antor was used for redroot pigweed (*Amaranthus retroflexus* L.) control in sugarbeet at 6 quarts per acre. Like ethofumesate, Antor often was incorporated for best weed control results since it required 1-inch of rainfall for activation. Registration was discontinued due to environmental concerns over its substantial use-rate.

Recently, there has been conversations about Antor as weed control in sugarbeet becomes more challenging due to wide-spread herbicide resistance. Antor had a reputation for controlling pigweed and many wondered about its activity on waterhemp. We were able to source Antor from an unopened container located in Idaho in 2025. The objectives of this experiment were to evaluate Antor for control of waterhemp in sugarbeet.

Materials and Methods

An experiment was conducted near the American Crystal Sugar Technical Center, Moorhead, MN. Wheat stubble was tilled with a chisel plow in fall 2024 and with a Kongskilde S-tyne field cultivator with rolling baskets in spring of 2025 to prepare the seedbed. The experimental area was fertilized according to soil test before secondary tillage. Preplant herbicide treatments were applied using a bicycle wheel plot sprayer with a shielded boom to reduce particle drift and calibrated to deliver 17 GPA through 8002XR nozzles (XR TeeJet® Flat Fan Spray Tips, TeeJet® Technologies, Glendale Heights, IL) spaced 20 inch apart and pressurized with CO2 at 40 psi. Herbicide treatments (Table 1) were immediately incorporated using the same Kongskilde S-tyne cultivator preset to incorporate treatments 1-inch into the soil (tillage equipment set 2-inches deep) and operated parallel to sugarbeet rows.

Table 1. Herbicide treatments, herbicide rates and application timing.

Trt Num	PPI Herbicide[a]	Postemergence Herbicide	Rate	Sugarbeet stage
			(fl oz, pt, or qt/A)	(lvs)
1	Antor		3 qt	PPI
2	Antor		6 qt	PPI
3	Nortron		3p	PPI
4	Nortron		6p	PPI
5	Eptam		3.5p	PPI
6		PowerMax3 + etho / PowerMax3 + etho	25 + 6 / 25 + 6	2 / 6

[a]Roundup PowerMax3 mixed with ethofumesate at 25 + 6 fl oz/A with NIS and Amsol liquid AMS at 0.25% and 2.5% v/v 2-times POST following PPI treatments.

Sugarbeet were planted in rows spaced 22 inch apart and 1.25 inch deep at approximately 63,500 seed per acre. Visible sugarbeet growth reduction injury was evaluated using a 0 to 99% scale (0 is no visible injury and 99 is complete loss of plant / stand) and visible waterhemp control using a 0 to 99 scale (0 is no injury and 99 is complete control). Evaluations were approximately 28, 35, and 42, 49 and 56 days (+/- 3 days) after sugarbeet plant. Experimental design was randomized complete block (RCBD) with four replications. Data were analyzed as a RCBD with the ANOVA procedure of ARM, version 2025.5 software package at the alpha = 0.1 level.

Results

Sugarbeet injury was negligible 30 and 44 days after planting (DAP) (Table 2). Sugarbeet injury was greatest from Eptam at 3.5 pt/A and Nortron at 3 pt/A, 30 DAP. Sugarbeet injury averaged across treatments ranged from 75% to 47%, 30 to 51 DAP. Waterhemp control tended to be best with Eptam at 3.5 pt/A fb 2-times Roundup PowerMax3 mixed with ethofumesate at 25 + 6 fl oz/A (Table 2, Figure). Antor at 6 qt/A provided waterhemp control greater than Antor at 3 qt/A. Ethofumesate (Nortron) at 6 pt/A tended to provide waterhemp control greater than ethofumesate at 3 pt/A. We observed similar control from Antor at 6 qt/A and ethofumesate at 6 pt/A.

Table 2. Percent visible sugarbeet injury and waterhemp control in response to herbicide treatment, Moorhead, MN, 2025.[a]

PPI Herbicide[a]	Postemergence Herbicide	Rate	Percent Sugarbeet Injury		Percent Waterhemp Control			
		(fl oz, pt, or qt/A)	30 DAP	44 DAP	30 DAP	37 DAP	44 DAP	51 DAP
Antor		3 qt	0 b	0 b	65 c	51 c	43 d	18 cd
Antor		6 qt	0 b	0 b	78 b	76 ab	70 ab	69 b
Nortron		3p	13 a	0 b	69 c	65 b	50 cd	33 c
Nortron		6p	3 b	3 b	80 b	75 ab	63 bc	60 b
Eptam		3.5p	15 a	10 a	89 a	83 a	81 a	89 a
	PowerMax3 + etho / PowerMax3 + etho	25 + 6 / 25 + 6	0 b	0 b	68 c	29 d	39 d	10 d
P-Value			0.0045	0.0652	0.0010	0.0001	0.0007	0.0001

[a]Sugarbeet injury or waterhemp control followed by the same alphabetical letter indicates non-statistical differences between treatments at the 0.10 alpha level

[b]Roundup PowerMax3 mixed with ethofumesate at 25 + 6 fl oz/A with NIS and Amsol liquid AMS at 0.25% and 2.5% v/v 2-times POST at the 2- and 6-lf stage.

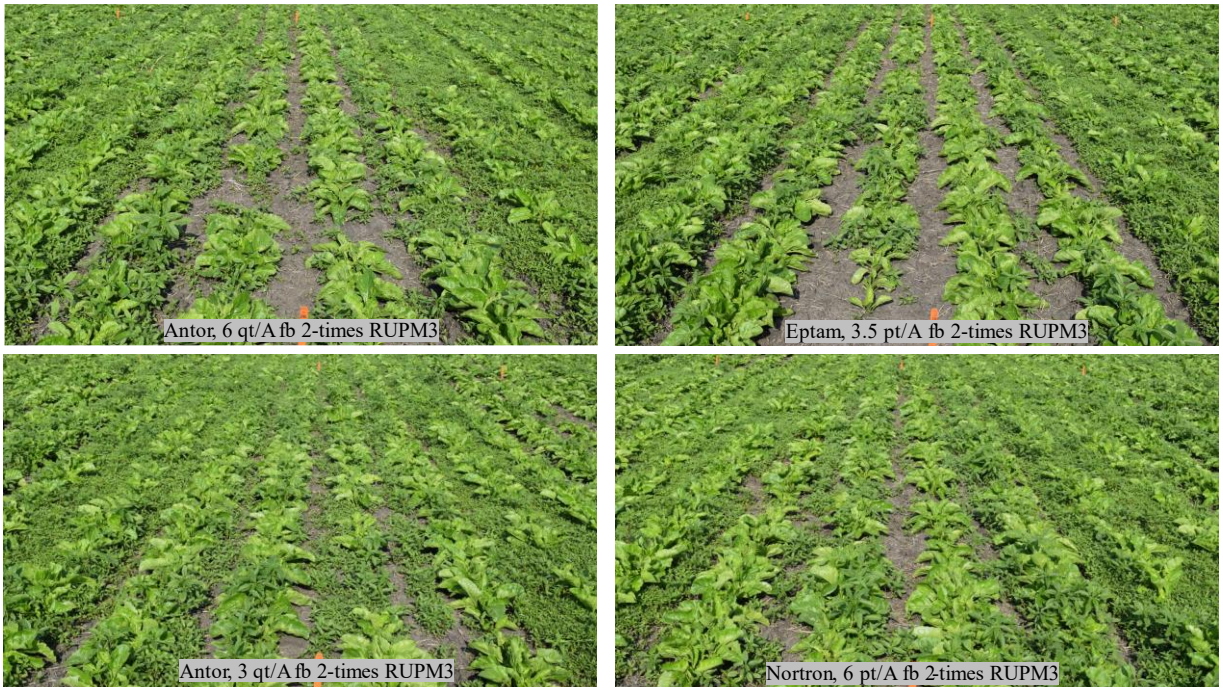


Figure. Waterhemp control 44 days after planting, Moorhead, MN, 2025.

Discussion
Antor was approved in sugarbeet at up to 1.5 gallon per acre (6 qt/A) for control of redroot pigweed in sugarbeet. The spectrum of grass and broadleaf control from Antor is relatively narrow in sugarbeet in MN and ND. According to the 1987 Sugarbeet Production Guide published by the Cooperative Extension Service, North Dakota State University and the University of Minnesota, Antor provides good to excellent control of redroot pigweed and fair to good control of black nightshade. Control of other broadleaves was no greater than poor. Antor provided broad spectrum grass control, providing fair to good control of barnyardgrass, foxtail species and wild oat.

Ethofumesate provided waterhemp control similar to Antor. Unfortunately, the use rate combined with control of waterhemp similar to ethofumeate and lack of spectrum prevents us from becoming excited about Antor for weed control in sugarbeet in MN and ND.

Acknowledgements
Special thanks to Mr. Clark Alder, Sales Manager, KWS Seeds, Middleton, ID for sourcing Antor from a storage unit out back. Evaluating waterhemp control from Antor was on my 'bucket list' and provides personal gratification since it connects my waterhemp control program to Dr. Dexter's program for redroot pigweed control. I feel I can rest easy now.

SOIL MANAGEMENT PRACTICES

EVALUATION OF SUGAR BEET LIME (PCC) AS A LIMING SOURCE FOR CORRECTING SOIL ACIDITY

Project Leader: Daniel Kaiser – University of Minnesota Twin Cities

Other Personnel Involved: Mark Bloomquist, Agricultural Research Department, Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota; David Mettler. Research Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, Minnesota

*The term **PCC** (precipitated calcium carbonate) is used throughout this report and refers to sugar beet, factory, or waste lime.*

Justification: The use of sugar beet lime has increased in past years due to benefits such as reduced disease incidence and potentially supplementing fertilizer applications for crops. However, more soil in areas of fields in Western Minnesota has become more acidic recently increasing the need for a local source of lime. There has been very little lime research in Minnesota in the last 20 years and the benefits of liming to an optimal pH have not been assessed. If sugar beet lime is used as a liming source the additional nutrients such as phosphorus or potassium may additionally have added benefits resulting in greater yield. A study funded by the Minnesota Soybean Research and Promotion council is underway focused on evaluating how lime materials change soil pH and the overall value of lime applications to crops. I am utilizing sugar beet lime in a few of the locations and one area that I need to address with whether the beet lime is increasing the uptake of nutrients such as phosphorus where any increases of yield from the lime may be confounded with increased nutrient availability over the five years of study at each location.

In western Minnesota PCC is being used as a lime source but I have not found much information regarding pH correction with this product. While PCC is not always applied to correct pH, the impacts on soil pH still are important to know how quickly soil acidity can be corrected and how pH is affected by multiple rates of PCC looking not only at the year of application but future years where crop yield may be more impacted. Since PCC contains other nutrients one challenge with comparing PCC to other lime sources is determining potential effects due to pH change versus the uptake of other beneficial nutrients that may be in the PCC. Plant tissue analysis can help to sort out potential effects of nutrients applied with the PCC compared to impacts related to pH change alone.

Application of PCC as a liming source is occurring in Western MN. The liming studies established are put in place to focus on the economics of liming in different areas of Minnesota to determine whether lime pays over five cropping years. Additionally, any P or K in PCC may provide a benefit to crops, but having more longer-term data would have great value as benefits from lime or PCC may occur 1 to 2 years or more following application.

The use of sugar beet lime has increased in areas due to benefits for disease suppression (Windels et al., 2006) and potential nutrient benefits (Sims et al., 2010). Sugar beet lime also contains calcium carbonate which is a source of lime that can be utilized to adjust soil pH. Current Minnesota lime recommendations suggest maintaining a soil pH of at least 6.0 for most crops (Kaiser and Rosen, 2023). Some soils in central and Western Minnesota are becoming more acid where lime should be applied and more research on the impact of sugar beet lime on modifying soil pH should be studied. Since been lime contains more than just calcium carbonate, any trials to assess the impact of lime on pH change and subsequent yield increases to the crop can be confounded by the addition of other nutrients. Additional soil and plant tissue sampling can be beneficial to help determine whether potential benefits are due to a change in soil pH or other nutrients contained in sugar beet lime.

Objectives:

1. Compare soil pH change from precipitated calcium carbonate (PCC) compared to traditional lime sources.
2. Evaluate nutrient uptake in crops following PCC application.

Table 1. Summary of soil test data collected prior to initial treatment application at two locations in Minnesota. Samples were collected from the 0-6 and 6-18" depths and are a composite of 8 separate cores collected from each split-split plot and averaged for each location.

Start Year	Location	Soil Type	0-6" Soil Test[/1]			pH		Sikora Buffer	
			P	K	OM	0-6"	6-18"	reg	1:3
			--ppm--		-%-			---ppm----	
2024	Sandborn	Normania	58	184	3.1	5.2	5.8	6.3	na
2025	Nicollet	Cordova	17	177	6.3	6.3	--	6.8	na

/1: P, Bray-P1 phosphorus; K, ammonium acetate K; pH, soil pH; OM, organic matter; SO_4-S, sulfate-S extracted by mono-calcium phosphate.

Materials and Methods: Lime rate trials were established at 2 locations (Table 1) in southern Minnesota (2 additional trials will be established in spring 2026). At each site six rates of lime (including a non-limed control) will be applied as ag lime sourced from a Minnesota quarry, pelletized lime, and PCC sourced from the Southern MN beet sugar cooperative (A summary of pertinent lime analyses are given in Table 2). Lime will be applied in the spring and crop yield will be measured over a period of five growing seasons. Soil samples will be collected from all plots before lime application and each fall post-harvest to assess pH change over time. For the sites with PCC application, plant samples will be taken at the early reproductive stages for corn and soybean (R2) by sampling either the leaf opposite and below the ear for corn or the uppermost fully developed trifoliate in soybean. Samples will be dried, ground, and analyzed for major macro- (nitrogen is not measured) and micro-nutrients. Grain samples will additionally be collected and analyzed for nutrient concentration.

Table 2. Summary of measured variables for the lime materials used in the study. The effective calcium carbonate equivalency (ECCE) is the value calculated for the lime at the time of application and can vary based on the moisture concentration of the material.

Source	ECCE	Ca[/1]	Mg[/1]	Nutrient Concentration[/2]				
				P	K	B	Cu	Zn
	Lb/ton			----------ppm----------				
Quarry Lime	1503	158460	99400	--	--	--	--	--
Pell Lime	1847	499630	1380	--	--	--	--	--
PCC	1381	309631	15872	3739	875	13.4	17.8	34.5

[1/]Values are calculated in ppm. ppm/10,000 = %.
[2/]Calcium and Magnesium concentration was measured on all materials. Additional nutrients were measured on the PCC material.

Table 3. Summary of limestone source and rate impacts on corn or soybean grain yield.

Location	Source	Total ENP Rate – 5yr						Avg
		0	1000	2000	3000	4000	5000	
		----------bushels per acre (13 or 15.5%)----------						
Sandborn	Lime	206	216	234	203	214	210	214
Corn 2024	Pell Lime	210	196	196	216	215	215	208
	Annual Pell	209	217	206	225	198	205	210
		206	216	234	203	214	210	
Sandborn	Lime	63.0	67.2	67.3	60.2	69.2	64.7	65.3
SB 2025	Pell Lime	69.4	66.5	69.2	61.9	67.2	66.2	66.7
	PCC	66.6	67.0	65.0	67.4	71.6	70.1	67.9
		66.3	66.9	67.2	63.2	69.3	67.0	
Nicollet	Lime	263	254	279	255	271	274	266
Corn 2025	Pell Lime	265	271	268	266	228	259	260
	PCC**	269	276	249	297	294	256	274
		266	267	265	273	265	263	

**Denotes where a significant source by rate interaction occurred
SB=Soybean

2025 Data Summary

I am providing a general summary of results through the 2025 growing season. These are long-term studies so I will not include conclusions in this report as it is too early in most cases to conclude effects of the treatments.

Crop yield data starting in 2024 is listed in Table 3. To date 2 years of data have been collected at Sandborn and one year of data is collected from Nicollet. Lime was applied in the spring of 2024 at Sandborn and spring of 2025 at Nicollet. There was a lot of random variation in yield across the trials which led to some issues determining significant effects with 1 year of data. Over time I can analyze the data across years for individual crops to determine whether the lime sources impacted yield. There was no indication of a yield response in either corn or soybean at the Sandborn site. At Nicollet there was a significant interaction between lime source and rate for the PCC treatments possibly indicating some increase in yield with PCC. However, there was no general increase in yield as the rate of PCC increased. Corn grain yield was highest with the 3000 and 4000 lb ENP rates but a relatively low yield with 2000. I have attempted to clean up the data by looking at spatial patterns in the random variability due to soil properties across the stie but that has not cleared up the variation enough to find significant responses.

Plant tissue data was used to assess the availability of nutrients specifically from the PCC. Using the values in Table 2, applications of 1000 lbs ENP per acre would supply 5.4 lb P and 1.3 lb K (12.4 lbs P_2O_5 and 1.6 lbs K_2O). The highest application rate (5000 lb ENP per acre) would supply roughly enough P to cover what is removed in an average corn crop. Past research has shown that applications of PCC can increase soil test P but no increase in crop yield. However, much of this work was conducted on high pH soils so it is likely that any calcium bound P would have very little solubility in high pH soils that are already high in Ca. Leaf tissue P concentration data are given in Table 4. The only significant response occurred for the soybean crop grown at Nicollet in 2024 where leaf tissue P concentration was higher with PCC compared to the other two sources. However, there was no effect of application rate on leaf P concentration. Leaf K concentration was affected by rate at Sandborn in 2024 and Nicollet in 2025, but the general effect was a decrease in leaf K concentration with increasing rate of lime (Table 5). This decrease in concentration was likely a result of increasing amounts of Ca applied that can affect the uptake of K. Leaf Zn and S were also measured but the data are not shown. The only significant increase in Leaf Zn and S was due to the application of PCC at Sandborn in 2024.

Grain P and K concentration data are summarized in Tables 6 and 7, respectively. There was no effect of lime source or rate on the concentration of P or K in corn or soybean grain in 2024 or 2025.

Fall post-harvest soil test data are summarized in Tables 8, and 9, respectively. Only soil pH was measured in the fall of 2024 from the Sandborn study, and I could not determine soil P and K concentration at that site that year. The data in Tables 8 and 9 summarize only the Fall 2025 data. Soil samples were collected in the fall of 2024 from Sandborn but only pH was analyzed at that time. Soil phosphorus was greater with PCC at the Sandborn site. Soil test P trended greater at Nicollet but the variation in soil test across the sites was high ranging from 10 to 20 ppm across the site. There was some weak evidence of a yield increase with PCC at Nicollet which could be a result of the phosphorus applied. There was no increase in soil test K at Sandborn, but the soil test K was slightly greater with PCC applied at Nicollet. A summary of the change in soil pH is included in Figure 1. All three sources showed a similar increase in pH when applied at the same ENP rate. Soil pH change was greater at Sandborn where the lime had more time to react. A slower change in soil pH is expected as most lime materials are not ground fine enough to change soil pH rapidly.

Table 4. Summary of limestone source and rate impacts on corn ear leaf or soybean uppermost fully developed trifoliate phosphorus concentration collected at R2 from 2 fields in Minnesota.

		Total ENP Rate – 5yr						
Location	Source	0	1000	2000	3000	4000	5000	Avg
				---------- (% P)----------				
Sandborn	Lime	0.29	0.31	0.33	0.31	0.29	0.30	0.30b
Corn 2024	Pell Lime	0.32	0.33	0.30	0.34	0.31	0.31	0.31b
	PCC	0.35	0.34	0.34	0.36	0.34	0.34	0.34a
		0.32	0.33	0.32	0.34	0.31	0.32	
Nicollet	Lime	0.27	0.29	0.28	0.29	0.30	0.30	0.29
Corn 2025	Pell Lime	0.28	0.29	0.29	0.29	0.29	0.29	0.29
	PCC	0.27	0.29	0.28	0.29	0.30	0.28	0.28
		0.28	0.29	0.28	0.29	0.29	0.29	
Sandborn	Lime	0.63	0.51	0.57	0.60	0.60	0.56	0.58
Corn 2025	Pell Lime	0.58	0.51	0.53	0.58	0.65	0.56	0.57
	PCC	0.51	0.56	0.64	0.56	0.49	0.63	0.57
		0.57	0.52	0.58	0.58	0.58	0.58	

**Denotes where a significant source by rate interaction occurred

Table 5. Summary of limestone source and rate impacts on corn ear leaf or soybean uppermost fully developed trifoliate potassium concentration collected at R2 from 2 fields in Minnesota.

		Total ENP Rate – 5yr						
Location	Source	0	1000	2000	3000	4000	5000	Avg
				---------- (% K)----------				
Sandborn	Lime	1.98	1.88	1.90	2.00	1.93	1.89	1.93
Corn 2024	Pell Lime	2.04	2.04	1.95	2.03	1.98	1.96	2.00
	PCC	2.06	1.95	1.96	1.97	1.86	1.85	1.94
		2.03a	1.96bc	1.94ab	2.00a	1.92bc	1.90c	
Nicollet	Lime	1.28	1.31	1.28	1.26	1.21	1.32	1.28
Corn 2025	Pell Lime	1.36	1.33	1.28	1.28	1.26	1.30	1.30
	PCC	1.50	1.41	1.30	1.38	1.37	1.37	1.39
		1.38	1.35	1.29	1.31	1.28	1.33	
Sandborn	Lime	2.22	2.13	2.08	2.12	2.23	2.10	2.15a
Corn 2025	Pell Lime	2.06	2.10	2.28	2.09	2.02	2.19	2.12a
	PCC	2.20	2.12	2.14	2.12	1.84	1.99	2.07b
		2.16a	2.11a	2.17a	2.11a	2.03b	2.09ab	

**Denotes where a significant source by rate interaction occurred

Table 6. Summary of limestone source and rate impacts on corn or soybean grain phosphorus concentration collected from 2 fields in Minnesota.

		Total ENP Rate – 5yr						
Location	Source	0	1000	2000	3000	4000	5000	Avg
				---------- (% P)----------				
Sandborn	Lime	0.30	0.27	0.26	0.27	0.26	0.27	0.30b
Corn 2024	Pell Lime	0.29	0.27	0.29	0.27	0.26	0.27	0.31b
	PCC	0.28	0.27	0.27	0.26	0.27	0.27	0.34a
		0.29a	0.27b	0.27b	0.27b	0.26b	0.27b	
Nicollet	Lime	0.24	0.24	0.24	0.22	0.22	0.23	0.23
Corn 2025	Pell Lime	0.24	0.23	0.24	0.24	0.23	0.23	0.23
	PCC	0.21	0.23	0.24	0.23	0.22	0.24	0.23
		0.23	0.24	0.24	0.23	0.23	0.23	
Sandborn	Lime	0.55	0.55	0.51	0.52	0.52	0.52	0.53
Corn 2025	Pell Lime	0.51	0.51	0.53	0.52	0.50	0.52	0.52
	PCC	0.50	0.52	0.53	0.53	0.51	0.55	0.52
		0.52	0.53	0.53	0.52	0.51	0.53	

**Denotes where a significant source by rate interaction occurred

Table 7. Summary of limestone source and rate impacts on corn or soybean grain potassium concentration collected from 2 fields in Minnesota.

		Total ENP Rate – 5yr						
Location	Source	0	1000	2000	3000	4000	5000	Avg
				---------- (% K)----------				
Sandborn	Lime	0.38	0.34	0.34	0.34	0.34	0.35	0.35
Corn 2024	Pell Lime	0.37	0.34	0.39	0.36	0.35	0.35	0.36
	PCC	0.36	0.35	0.35	0.34	0.35	0.35	0.35
		0.37	0.34	0.36	0.35	0.35	0.35	
Nicollet	Lime	0.21	0.22	0.22	0.20	0.20	0.20	0.21
Corn 2025	Pell Lime	0.22	0.20	0.21	0.20	0.20	0.22	0.21
	PCC	0.19	0.21	0.22	0.21	0.20	0.21	0.21
		0.21	0.21	0.21	0.21	0.20	0.21	
Sandborn	Lime	1.26	1.25	1.17	1.17	1.15	1.18	1.20
Corn 2025	Pell Lime	1.18	1.17	1.22	1.19	1.13	1.19	1.18
	PCC	1.20	1.18	1.18	1.18	1.15	1.19	1.18
		1.21	1.20	1.19	1.18	1.14	1.18	

**Denotes where a significant source by rate interaction occurred

Table 8. Summary of limestone source and rate impacts on fall 2025 0-6” soil test phosphorus (Bray-P1) concentration from 2 fields in Minnesota.

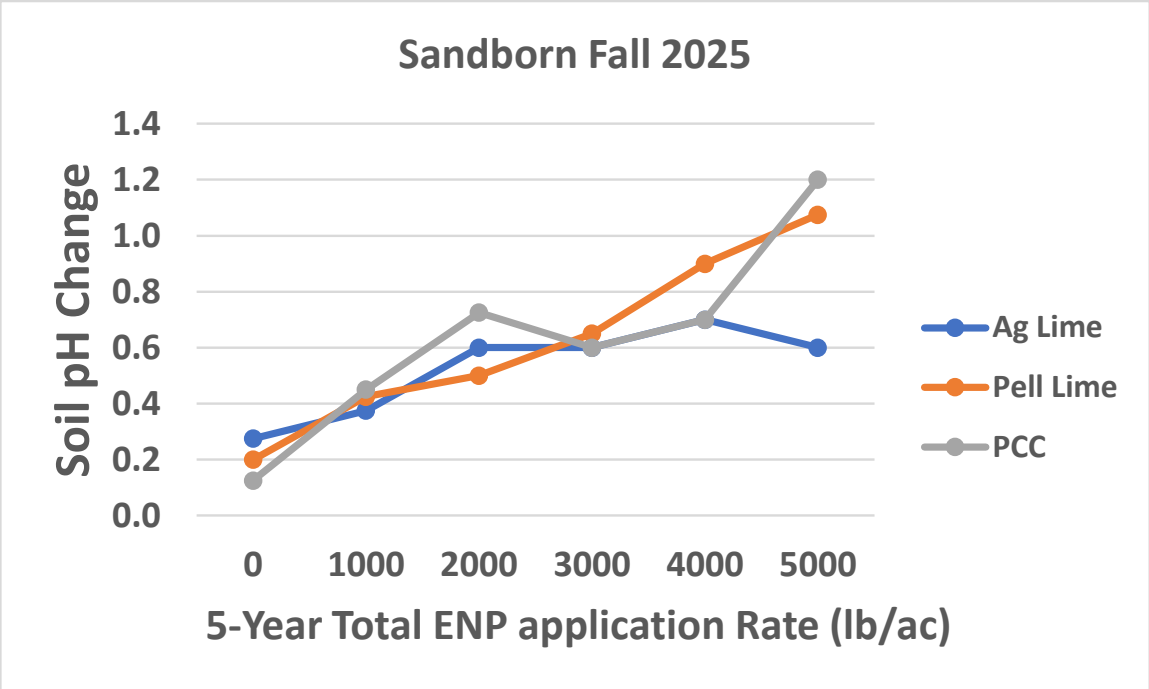
		Total ENP Rate – 5yr						
Location	Source	0	1000	2000	3000	4000	5000	Avg
				---------- (ppm P)----------				
Nicollet	Lime	11	11	12	12	10	13	11
Corn 2025	Pell Lime	11	12	12	11	10	12	11
	PCC	15	13	14	12	16	16	14
		12	12	12	12	12	14	
Sandborn	Lime	50	51	46	56	41	50	46b
Corn 2025	Pell Lime	59	55	49	55	46	59	45b
	PCC	47	53	48	60	51	50	56a
		52	53	48	57	46	53	

**Denotes where a significant source by rate interaction occurred

Table 9. Summary of limestone source and rate impacts on fall 2025 0-6” soil test potassium (ammonium acetate) concentration from 2 fields in Minnesota.

		Total ENP Rate – 5yr						
Location	Source	0	1000	2000	3000	4000	5000	Avg
				---------- (ppm K)----------				
Nicollet	Lime	144	150	141	145	142	152	145b
Corn 2025	Pell Lime	146	140	138	133	148	148	142b
	PCC	150	147	146	148	151	155	149a
		146a	145a	142b	142b	147a	151a	
Sandborn	Lime	155	162	138	164	138	160	153
Corn 2025	Pell Lime	163	157	149	150	143	182	157
	PCC	140	147	144	151	136	128	141
		153	155	144	155	139	157	

**Denotes where a significant source by rate interaction occurred



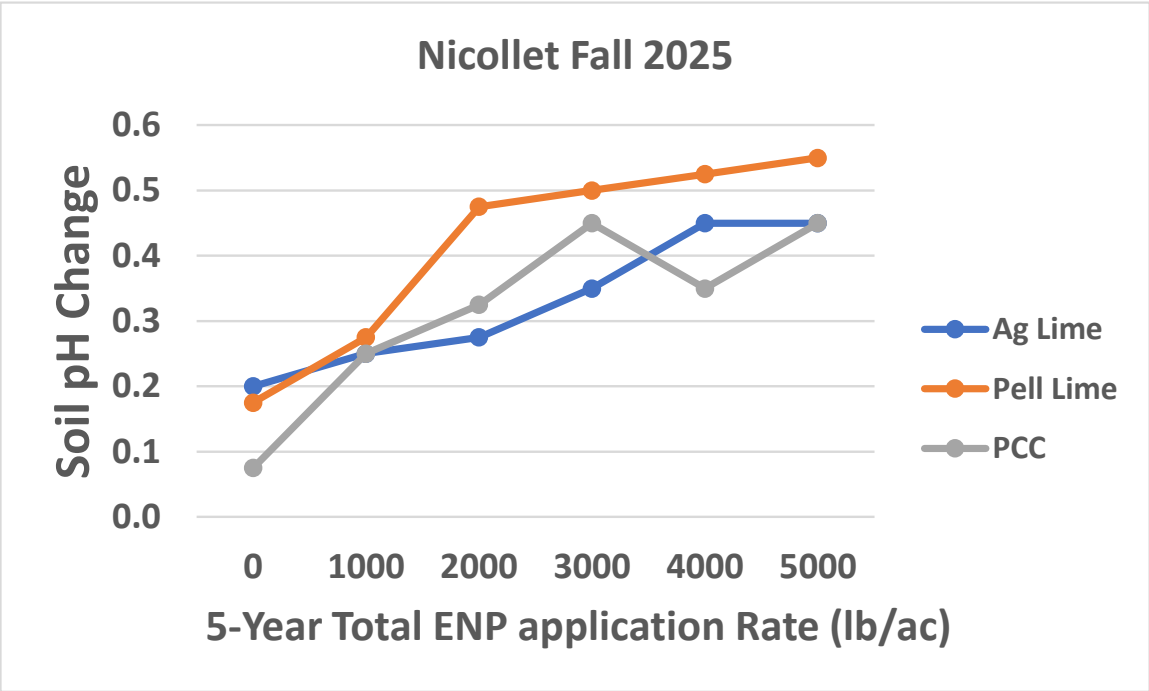


Figure 1. Summary of change in 0-6" soil water pH from initial lime application through the fall of 2025.

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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, yet establishing the economically optimum N application rate is challenging. In-season mineralization of organic nitrogen affects sugar yield and N fertilizer requirements of sugar beets. 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 in 2025. 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 two cover crop conditions (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 2025

Site	Soil	Drainage	Tillage	Cover Crop	n	Planting Date	Harvest Date	Mineralization Start	Mineralization End	Incubation Periods
D1	Loam	No tile	Conventional	No Cover	6	5/29/25	9/17/25	5/14/25	7/21/25	9
D2	Loam	No tile	Conventional	Fall Rye	6	5/29/25	9/17/25	5/14/25	7/21/25	9
D3	Loam	No tile	Strip-till	No Cover	6	5/29/25	9/17/25	5/14/25	7/21/25	9
D4	Loam	No tile	Strip-till	Fall Rye	6	5/29/25	9/17/25	5/14/25	7/21/25	9
E1	Silty clay	Tile	Conventional	No Cover	9	5/29/25	9/25/25	5/5/25	7/21/25	11
E2	Silty clay	No tile	Conventional	No Cover	1	5/29/25	9/25/25	5/5/25	7/21/25	11

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 two weeks during the growing season (May 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

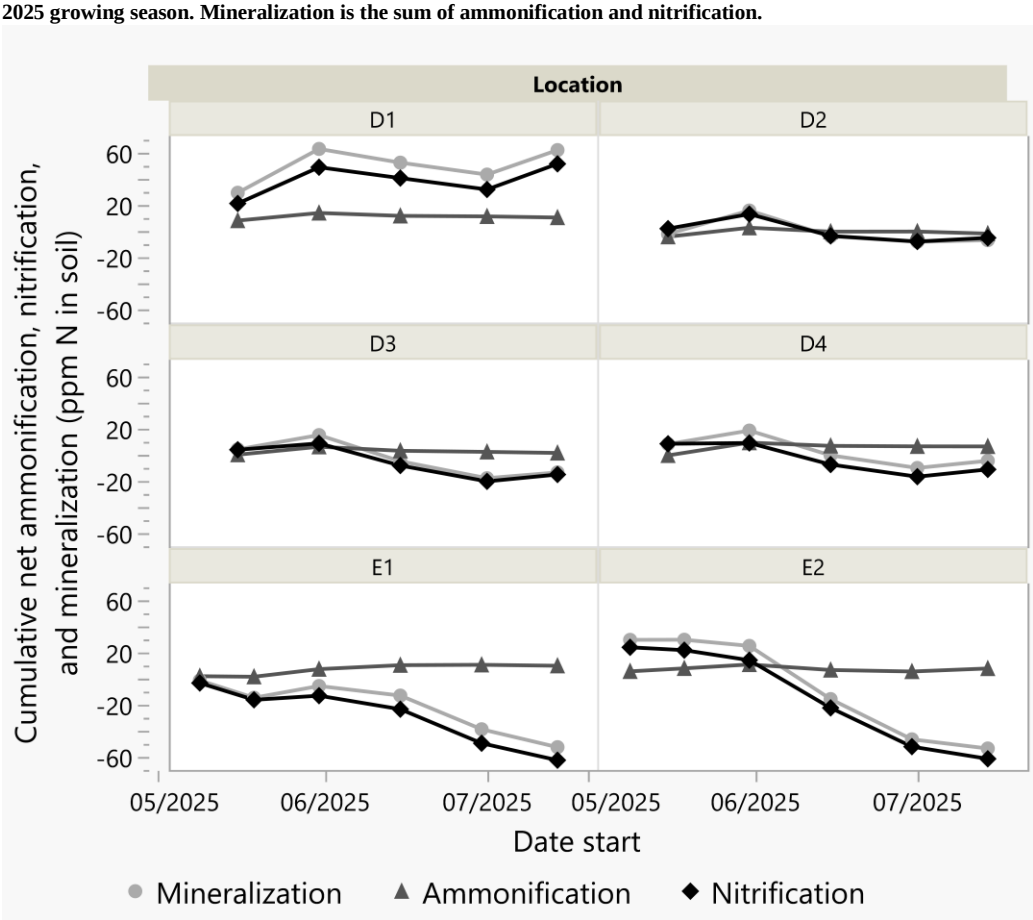
and net nitrification were calculated by subtracting post-incubation ammonium- and nitrate-N from initial values for each incubation period. Cumulative net mineralization was calculated by summing net mineralization from each incubation period.

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 "cover crop," were evaluated for collinearity using variance inflation factor (VIF) testing. None of the main factor terms were collinear with VIF < 10. Statistical analyses were carried out in JMP Student Edition 18.2.2 (JMP Statistical Discovery, 2025). 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 in May, June, and July 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 in Crookston, MN during the early 2025 growing season. Mineralization is the sum of ammonification and nitrification.



One three main factors were significantly associated with mineralization from May to July during the 2025 growing season: tillage, soil type, and rye cover crop. Drainage was not a significant factor during this period. Cumulative net mineralization was lower for strip-till plots than conventionally tilled plots, for rye plots than no cover, and for silty clay soils than loam soils. 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 and cover crop plots plots may have been slowed due to retention of crop residue (wheat stubble from the 2023 growing season) on the ground surface during the early part of the growing season (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 data analysis will link full growing season mineralization data to sugarbeet yield and quality data for the 2025 growing season. Additional research is needed to determine the impact of nitrogen cycling and its timing on sugarbeet yield.

Acknowledgements:

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SUGARBEET PHYSIOLOGY STORAGE

PROJECT TITLE: INTEGRATION OF TRANSCRIPTOME AND MEABOLOME ANALYSES IN SUGARBEET WOUNDING RESPONSE IN COMPARISON TO THE WILD SPECIES OF BETA MARITIMA (PROJECT #621)

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Background

Sugarbeet (*Beta vulgaris* subsp. *vulgaris*) is a cornerstone of U.S. agriculture, accounting for approximately 55-56% of total domestic sugar production (USDA-ERS, 2025). The transition from field to factory involves mechanical harvesting, which necessitates the removal of leafy tops through either mechanical defoliation (flail removal) or scalping (slicing the crown) (Eckhoff et al., 2023). While efficient, these mechanical processes cause significant wounding to the root tissue. This wounding trauma triggers intense metabolic shifts, specifically an increase in glycolysis and fermentation as the plant attempts to manage the stress (Fugate et al., 2025). Historically, postharvest injury has been linked to increased respiration rates and heightened susceptibility to microbial infections, leading to substantial sucrose loss during storage (Halvorson et al., 1978).

Despite these impacts, the wound-healing capabilities of commercial cultivars versus wild relatives remain largely unstudied. This research identifies sea beet (*B. vulgaris* subsp. *maritima*) as a potential "genetic reservoir" to enhance the natural wound-healing capacity and storage life of modern cultivars. Therefore, the aim of this study was to bridge the knowledge gap regarding the genetic mechanisms of wound healing by investigating the transcriptional and metabolomic responses of a commercial sugarbeet cultivar and two wild sea beet lines to harvest-induced injury.

Materials and Methods

The study utilized a comparative framework involving a commercial sugarbeet cultivar: *Beta vulgaris* (BTS), and two wild lines: *Beta maritima* (P334 and P408). A total of 60 sugarbeet samples were analyzed across different injury types (defoliated vs. scalped) and time intervals. Tissue was collected at: day 0: Freshly harvested controls and day 15 and day 30: post-injury (defoliated and scalped). Following wounding, sugarbeet roots were stored at 4 °C and 95% relative humidity to simulate storage conditions in a commercial sugarbeet pile.

Sugarbeet root tissue collected from the wounded site of the root at different time points was snap-frozen in liquid nitrogen and ground into a fine powder. Total RNA was extracted from the root tissue using a RNeasy® Plus Mini Kit (Qiagen GmbH, Hilden, Germany). The quality and quantity of total RNA were analyzed using Bioanalyzer 2100 (Agilent Technologies, CA, United States) and acceptable RIN number for samples >7.0. High quality RNA was used for mRNAseq library preparations. RNA sequencing libraries were prepared according to the Illumina's TruSeq-Stranded-RNA sample preparation protocol, followed by adapter trimming of the raw sequence reads via Trimmomatic (v 0.38). Sequence reads were aligned to the sugarbeet reference genome (EL10.2) using STAR (v2.7.11b) (Dobin et al., 2013) and Samtools (ver. 1.17) was used to convert SAM format to BAM format. The read counts were calculated using featureCounts (ver. 2.0.3). Identification of differentially expressed genes and further downstream analysis were conducted with an integrative RNA-seq analysis platform, iDEP 2.01 (Ge et al., 2018) with the default parameters. Metabolites were extracted in 800 µL of 80% methanol from ~50 mg fresh weight of finely ground sugarbeet root tissues prepared using Geno/Grinder 2010 instrument. A Liquid chromatography-mass spectrometry (LC-MS) (Waters, UPLC; Thermo, Q Exactive) system with an Acquity UPLC HSS T3 (2.1 × 100 mm; 1.8 µm) chromatographic column was used for metabolite analysis. The raw files (.raw) were imported into Compound Discoverer3.1 (CD) to perform spectral processing and database search for qualitative and quantitative analyses of detected metabolites. The biological significance of metabolites was determined through enrichment of metabolites associated with specific metabolic pathways. Metabolites were visualized using the 'pheatmap' package (Kolde and Kolde, 2015) in R (v1.0.12) with default parameters except for scale = "row" (https://CRAN.R-project.org/package=pheatmap).

Results and discussion

The study identified 29,299 unique genes across 60 samples from a commercial sugarbeet cultivar (BTS) and two wild sea beet lines (P334 and P408). Significant transcriptional divergence was observed between wild lines and a commercial cultivar regarding their response to injury as shown in the PCoA plot (Figure 1). The findings presented in this report are based on observations made from scalped beets on day 15. The P334 line (scalped at day 15) exhibited 3,801 upregulated genes and over 15 enriched pathways (Figure 2). The most prominent mechanism was Phenylpropanoid biosynthesis (44 genes), which is essential for structural fortification in wounded tissues. Key genes included Cationic peroxidase 1 (gene ID: *LOC104898205*) and Phenylalanine ammonia-lyase (gene ID: *LOC104898673*) (Data not shown). Phenylalanine ammonia-lyase (PAL) is regarded as the "gatekeeper" gene and it converts phenylalanine into cinnamic acid, the first step in

creating phenolic compounds (Vogt, 2010). Its high expression in wild lines suggests a rapid commitment to secondary metabolism following mechanical injury. While PAL generates the necessary building blocks (precursors), peroxidase facilitates the final polymerization of monolignols into lignin, establishing a recalcitrant physical barrier at the wound surface (Dixon and Paiva, 1995). Furthermore, Shikimate O-hydroxycinnamoyltransferase (gene ID: *LOC104884151*) was significantly differentially expressed. This enzyme is critical for redirecting carbon flow toward the synthesis of lignin precursors over soluble phenolics to ensure that the plant's energy is prioritized for physical repair (Hoffmann et al., 2004). Additional enrichment in P334 included the Zeatin biosynthesis (11 genes) which involved in hormonal regulation of cell division via adenylate isopentenyltransferase (gene ID: *LOC104896430*). Tryptophan metabolism (19 genes) was the third most enriched pathway in line P334. This pathway links secondary metabolism to defense signaling through enzymes such as tryptophan decarboxylase (TDC2) and tyrosine decarboxylase (Höglund et al., 2010).

Meanwhile, line P408 (scalped at day 15) exhibited 3,592 upregulated genes across 12 pathways (Figure 2), with a distinct emphasis on oxidative stress management via Glutathione metabolism (31 genes) (Figure 3). High expression of L-ascorbate peroxidase 3 and 5 (gene ID: *LOC104895166*, and gene ID: *LOC104895169*, respectively) (Data not shown) suggests a superior capacity to neutralize reactive oxygen species (ROS) at the wound site. These genes protect the cell from hydrogen peroxide (H_2O_2) accumulation (Caverzan et al., 2012). By keeping oxidative stress in check, the wild line prevents "runaway" programmed cell death, allowing healthy cells adjacent to the wound to divide and heal (Caverzan et al., 2012). In addition to phenylpropanoid biosynthesis (31 genes), P408 showed enrichment in Flavonoid biosynthesis (16 genes) (Figure 4). This pathway features Chalcone synthase (gene ID: *LOC104905367*) and Flavanone 3-hydroxylase (gene ID: *LOC104905155*), which were highly active in scalped roots by day 15. Chalcone synthase is the rate-limiting enzyme for flavonoid production; in the wounded tissue, it facilitates the synthesis of phytoalexins, natural antimicrobial compounds that inhibit microbial during storage (Dao et al., 2011).

From the observation above, the superior wound-healing capacity of wild sea beets is driven by three primary biological pillars: physical sealing, chemical defense and metabolic efficiency. Physical sealing: the Phenylpropanoid pathway supplies precursors that Cationic peroxidase 1 polymerizes into lignin, creating a physical seal that prevents moisture loss and pathogen entry. Chemical defense: upregulation of Chalcone synthase facilitates the production of chrysophanic acid and rhein observed in line P334 (Figure 5). These anthraquinone derivatives protect the wound while promoting cell proliferation to close the injury site. Compounds, particularly methoxylated phenolics like veratrole (linked to caffeic acid 3-O-methyltransferase genes, gene ID: *LOC104887972*) act as chemical deterrents against microbial rot which is important in minimizing sucrose loss during sugarbeet storage. Metabolic Efficiency: minimizing sucrose loss currently caused by high respiration in slow-healing commercial cultivar like BTS (Fugate et al., 2016).

From a breeding perspective, genes like *LOC104898205* (involved in lignification) are prime candidates for Marker-Assisted Selection (MAS) to improve healing from wound and mechanical injury stress. Introgressing glutathione metabolism traits from P408 could improve cellular integrity in storage piles (Fugate et al., 2016), directly increasing extractable sucrose yields. Modern genomic tools, such as CRISPR-Cas9, offer the potential to upregulate these phenylpropanoid pathways in commercial cultivars, bypassing the "yield drag" often associated with traditional wide-crossing.

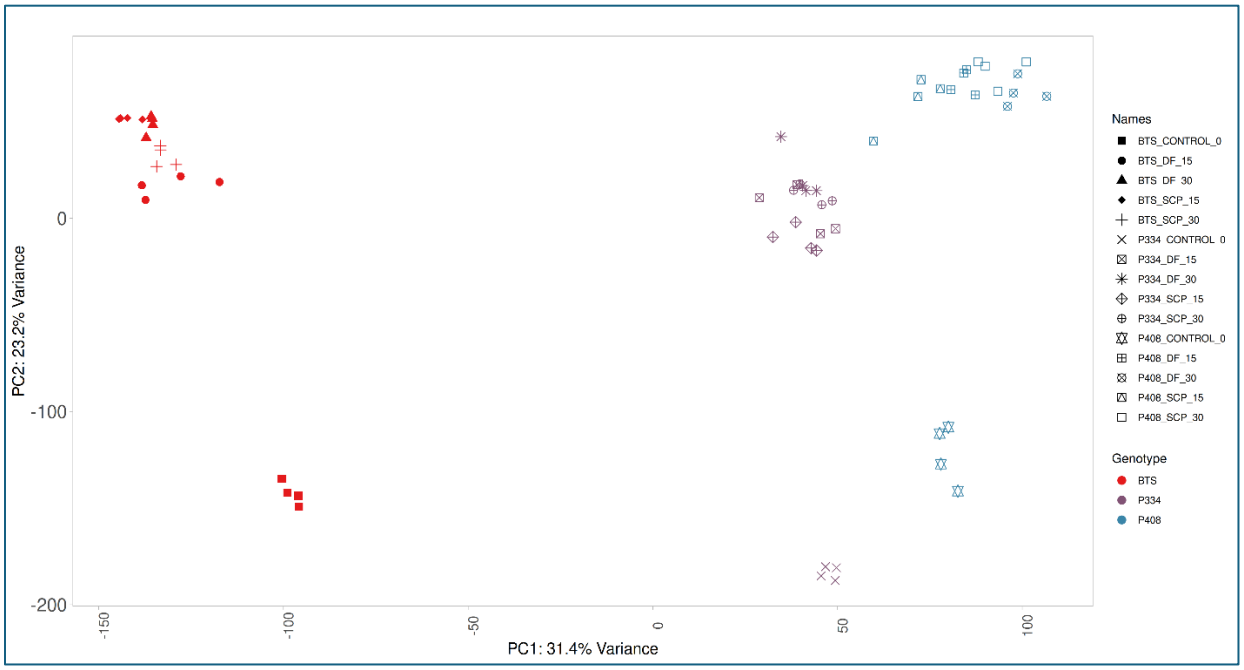

Figure 1: Principal coordinates analysis (PCoA) of RNA-seq transcriptomes from three sugarbeet genotypes (BTS, P334, and P408) subjected to defoliation (DF) or scalping (SCP) treatments. Data represents samples at harvest (Day 0) and following 15 or 30 days of storage at 4 °C. Legend abbreviations: CONTROL_0 (harvest), DF_15/30 (defoliated for 15/30 days), and SCP_15/30 (scalped for 15/30 days).

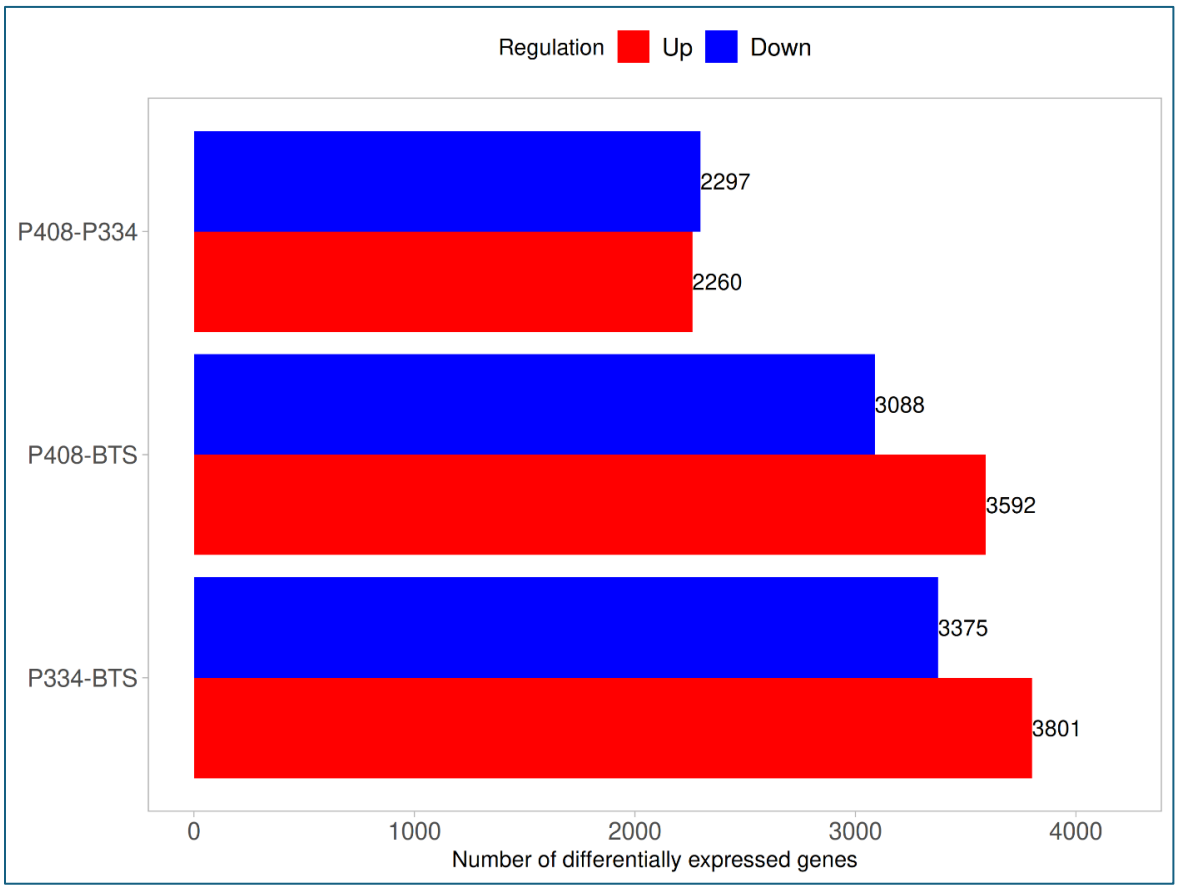

Figure 2: Number of differentially expressed genes in wild sea beet lines (P334 and P408) compared to a commercial line (BTS) and each other after 15 days of storage at 4 °C.

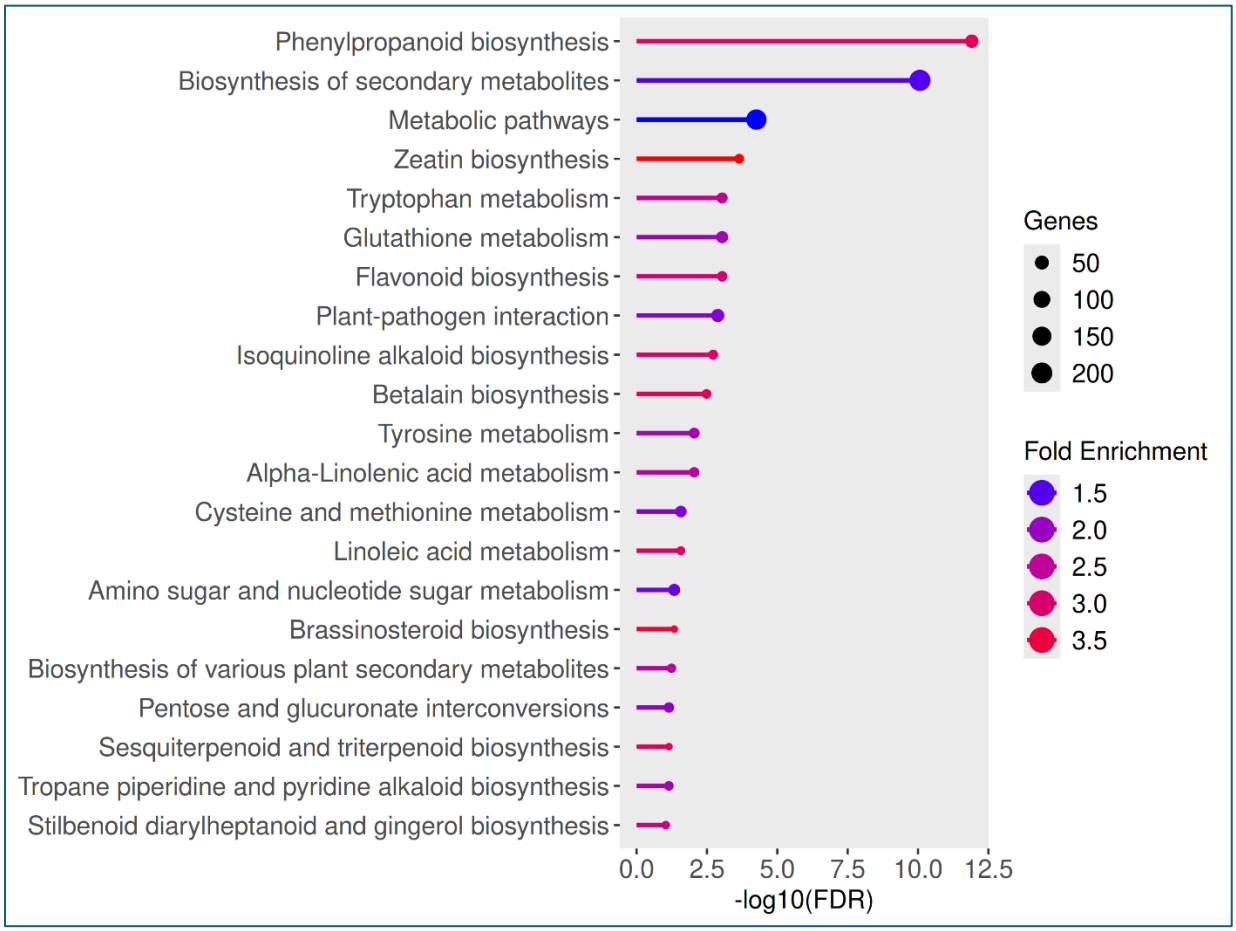

Figure 3: Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway enrichment analysis of target genes. This analysis identifies sugarbeet gene targets regulated by differentially expressed (DE) RNAs in scalped roots (P334) following 15 days of storage at 4 °C.

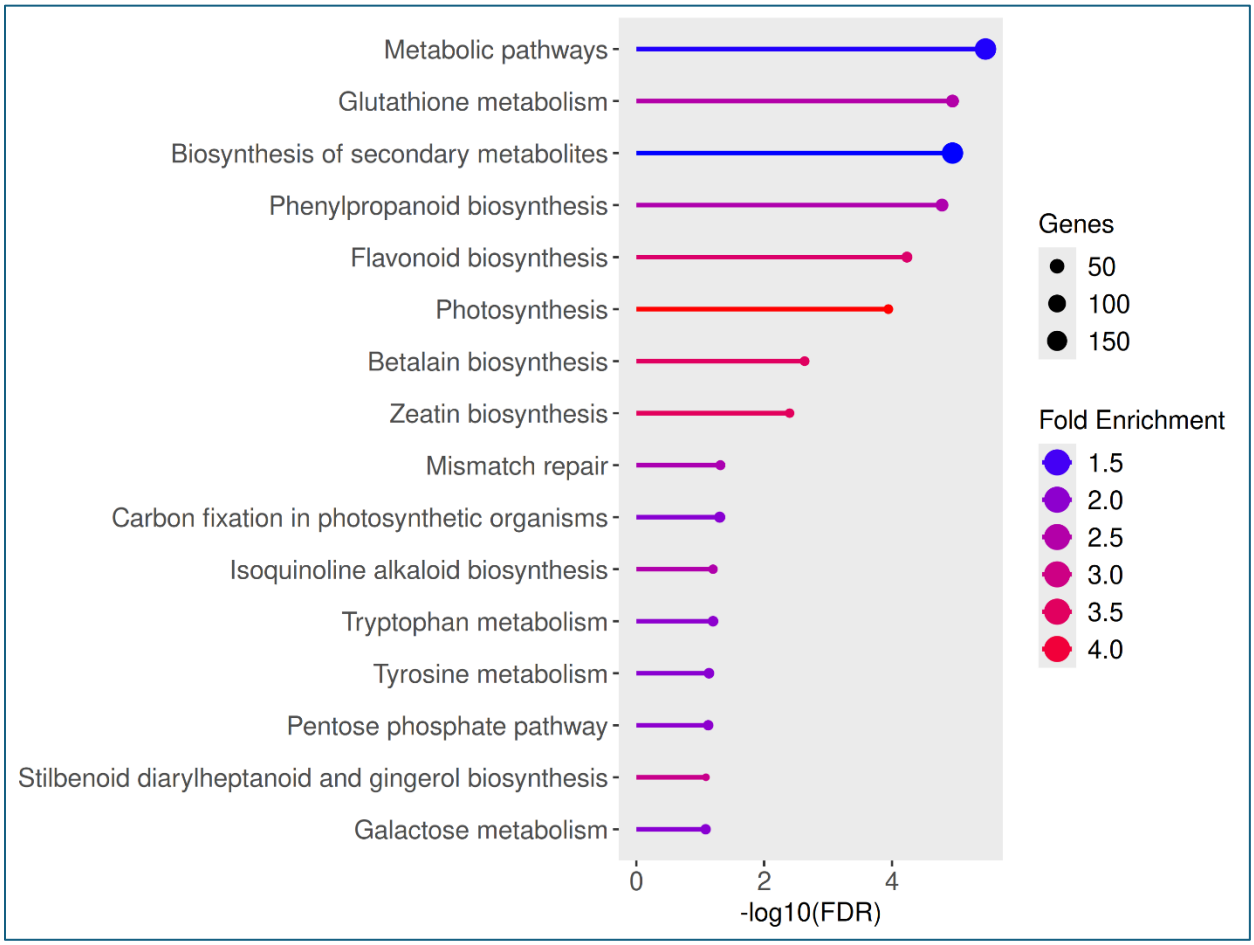

Figure 4: Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway enrichment analysis of target genes. This analysis identifies sugarbeet gene targets regulated by differentially expressed (DE) RNAs in scalped roots (P408) following 15 days of storage at 4 °C.

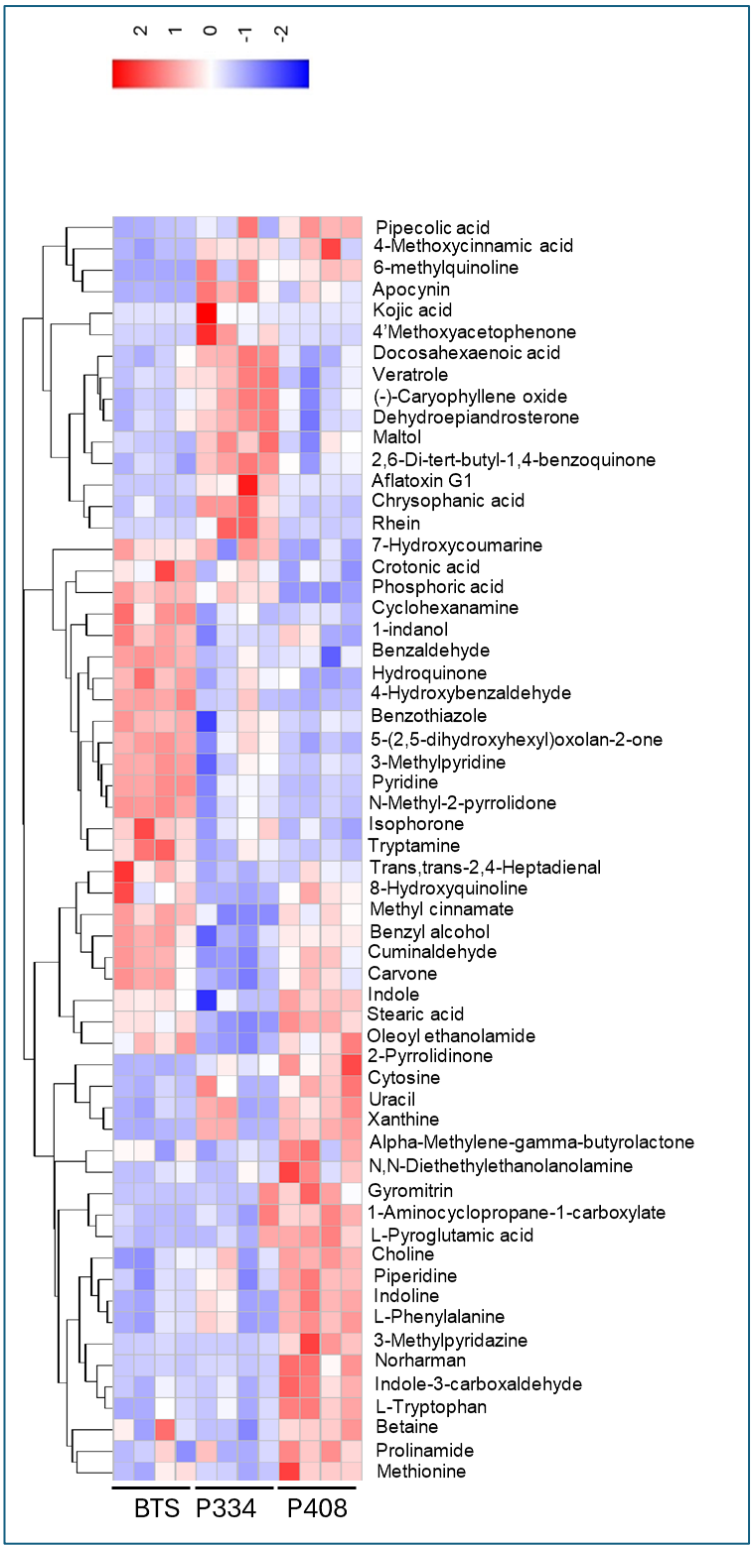

Figure 5: Untargeted metabolome analysis (+ve ion mode) of sugarbeet roots showed distinct metabolic patterns with the genotype at D15 scalped roots.

Conclusion

Wound healing is a complex physiological process involving the synchronized activation of diverse metabolic pathways to rebuild structural barriers and synthesize defense-related compounds. This research highlights that the transition from a wounded state to a stabilized root requires a coordinated genetic response, demonstrating that the wild lines P334 and P408 possess specialized genetic "toolkits" for rapid wound recovery that have likely been diluted in commercial cultivars. By identifying genes with sustained upregulation, particularly within the phenylpropanoid, glutathione, and flavonoid biosynthetic pathways, this study provides a clear framework for marker-assisted breeding. Leveraging these specific genes offers a roadmap for breeding sugarbeets with significantly improved storage characteristics, as enhancing these pathways in commercial lines can drastically improve postharvest outcomes by accelerating the formation of protective suberin and lignin layers while protecting the tissue from microbial invasion and oxidative damage. This fortification directly mitigates the respiration and microbial decay that leads to significant sucrose loss. Moving forward, the focus of this research will shift toward assessing the persistence of these upregulated genes in 30-day post-injury and defoliated samples to ensure that these protective mechanisms remain active throughout the entire storage lifecycle.

Acknowledgements

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ENTOMOLOGY & PLANTER TEST STAND CLINICS

TURNING POINT® SURVEY OF SUGARBEET INSECT PEST PROBLEMS AND MANAGEMENT PRACTICES IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2025

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Attendees of the 2026 Winter Sugarbeet Grower Seminars that were held at Fargo, Grand Forks, and Wahpeton, ND, as well as Willmar, MN were asked about their 2025 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. Unfortunately, technical issues with the survey system prevented administration of the survey at the Grafton seminar.

Initial questioning involved identifying the county in which grower respondents produced the majority of their sugarbeet crop in 2025. Those results are presented in Tables 1-4. The majority (41%) of Fargo seminar attendees indicated that the majority of their sugarbeet crop was grown in Clay County, MN, however, an additional 27% of the attendees reported growing the majority of their sugarbeet crop in Norman or Mahnomen counties in Minnesota (Table 1). Producers who grew sugarbeet in Cass and Traill counties of North Dakota and Becker County, MN were all tied at 9% of the Fargo seminar audience. One attendee of the Fargo seminar indicated producing the majority of their sugarbeet crop in Barnes County, ND.

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

County	Number of responses	Percent of responses
Barnes	1	5
Becker	2	9
Cass	2	9
Clay	9	41
Norman/Mahnomen	6	27
Traill	2	9
Totals	22	100

The largest portion (57%) of Grand Forks grower seminar attendees indicated that the majority of their sugarbeet production occurred in Polk County, MN (Table 2). An additional 17% of grower attendees at Grand Forks responded that most of their sugarbeet was grown in Grand Forks County, ND. About 11% of Grand Forks seminar attendees grew most of their sugarbeet crop in Walsh County, ND, and 9% of attendees represented Traill County, ND. Additionally, Marshall County, MN was represented by 3% of grower respondents at the Grand Forks seminar, as was the combination of Pennington and Red Lake counties of Minnesota. The same proportion (3%) of Grand Forks grower attendees reported that they grew the majority of their beet crops in counties that were not represented as a choice for this question.

Table 2. 2025 Grand Forks Grower Seminar – county in which sugarbeet was grown in 2025

County	Number of responses	Percent of responses
Grand Forks	6	17
Marshall	1	3
Pennington/Red Lake	1	3
Polk	20	57
Traill	2	6
Walsh	4	11
Other	1	3
Totals	35	100

Responses to this question at the Wahpeton winter sugarbeet grower seminar indicated that 41% of the attending producers grew the majority of their sugarbeet crop in Wilkin County, MN, with another 20% of grower attendees reporting that most of their crop was produced in Richland County, ND (Table 3). An additional 15 and 13% of respondents at the Wahpeton seminar indicated that most of their sugarbeet production occurred in Clay and Grant counties of Minnesota, with the remainder of respondents responding that they produced the majority of their beet crop in Cass and Traverse County, ND (4% each), Roberts County, SD (2%), and Stevens County, MN (2%) in 2025.

Table 3. 2025 Wahpeton Grower Seminar – county in which sugarbeet was grown in 2025

County	Number of responses	Percent of responses
Cass	2	4
Clay	8	15
Grant	7	13
Richland	11	20
Roberts	1	2
Stevens	1	2
Traverse	2	4
Wilkin	22	41
Totals	54	100

The highest proportion (38%) of Willmar grower seminar attendees reported that most of their sugarbeet production acreage in 2025 was grown in Chippewa County, MN (Table 4). A sizable amount (29%) of attendees reported growing most of their sugarbeet crop in Renville County. An additional 10, 8, and 5% of grower respondents at the Willmar seminar grew most of their beets in Swift, Kandyohi, and Redwood counties of Minnesota, respectively, with the remainder of respondents responding as either producing the majority of their sugarbeet crop in the Minnesota counties of Pope or Yellow Medicine (about 1% each), or in a county not listed as a choice for this question (5% of grower respondents) in 2025.

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

County	Number of responses	Percent of responses
Chippewa	30	38
Kandyohi	6	8
Pope	1	1
Redwood	2	3
Renville	23	29
Yellow Medicine	1	1
Stevens	4	5
Swift	8	10
Other	4	5
Totals	79	100

This report is based on grower responses about their production activities on an estimated 126,450 acres of sugarbeet grown in 2025 by 168 grower respondents that attended the 2025 Fargo, Grand Forks, Wahpeton, and Willmar Winter Sugarbeet Grower seminars (Table 5). Across all seminar surveys, the majority (41%) of respondents reported growing sugarbeet on between 400 and 799 acres during the 2025 production season. That represents a 7.9% increase of production in this acreage-per-grower category compared to that recorded from the 2024 growing season. An additional 21% from across all grower seminars produced beets on between 800 and 1,500 acres. A total of 11% of respondents reported growing sugarbeet on 1,500 acres or more in 2025, whereas just 17% of respondents overall produced sugarbeet on 299 or fewer acres.

Table 5. Ranges of sugarbeet production acreage in 2025 by 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	20	0	5	0	5	20	25	10	20	10	5
Grand Forks	34	0	9	6	3	21	24	6	18	12	3
Wahpeton	51	4	8	6	8	25	16	14	16	4	0
Willmar	63	6	5	10	17	22	14	10	2	6	8
Totals	168	3	7	7	10	23	18	10	11	7	4

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 2025 (Table 6). That was a 24% decrease compared to the responses recorded during the previous survey regarding the 2025 growing season. Additionally, about 21% of all seminar location respondents viewed springtails as their worst insect pest problem during the 2025 growing season. Grasshoppers were rated as the worst insect pest during 2025 by 16% of all seminar location respondents. Other insect groups identified by grower respondents across all four seminar locations as causing problems in 2025 included cutworms, wireworms, and white grubs, (11, 5, and 3%, of respondents, respectively).

At the Fargo seminar, 22% of grower respondents identified springtails as their worst insect pest problem in 2025, whereas an even split (17% each) of respondents at the Fargo grower seminar indicated that either cutworms or sugarbeet root maggot was their worst insect pest. An additional 11% of Fargo respondents listed armyworms as their worst insect pest problem. No other insect pests were identified as being a major problem by Fargo attendees.

The majority (62%) of respondents at the Grand Forks seminar identified the sugarbeet root maggot as their worst insect pest problem. That reflected a 55% increase over that reported for the 2024 growing season by Grand Forks grower seminar attendees. Springtails were reported by 22% of Grand Forks attendees as being their worst insect pest problem. Grasshoppers were reported as being the most important insect pest problem by 8% of Grand Forks respondents, and an additional 8% at that location reported that another insect pest not listed as a choice was their worst insect problem.

For this question at the Wahpeton seminar, 29% of respondents indicated that grasshoppers were their worst insect pest problem, and 20% ranked cutworms as their worst insect pest problem. An additional 9% of Wahpeton respondents viewed sugarbeet root maggot as being their most significant insect pest, which was a considerable increase from just 3% of respondents in relation to the 2024 crop year. Springtails and armyworms were each ranked as the top insect pest for 7% of Wahpeton grower seminar respondents. Similarly, white grubs and wireworms were each viewed as the worst insect pest problem by 4% of respondents at Wahpeton. Finally, just 2% of Wahpeton respondents ranked Lygus bugs as their worst insect pest during the 2025 growing season.

In contrast to responses from the three Red River Valley grower seminars, results from the Willmar seminar indicated that 47% of respondents viewed cutworms as their worst insect pest problem in sugarbeet, and an additional 44% listed Lygus bugs as their key insect pest during the 2025 growing season. The only other insects that were reported as being growers' worst insect pest problem were armyworms and grasshoppers, at 3% of Willmar respondents each.

Table 6. Worst insect pest problem in sugarbeet in 2025

Location	No. of responses	Army-worms	Cut-worms	Grass-hoppers	Lygus Bugs	Root maggot	Spring-tails	White Grubs	Wire-worms	Other
		% of responses								
Fargo	18	11	17	0	0	17	22	0	0	33
Grand Forks	37	0	0	8	0	62	22	0	0	8
Wahpeton	45	7	20	29	2	9	7	4	4	18
Willmar	32	3	47	3	44	0	0	0	0	0
Totals	132	5	20	13	11	23	11	2	2	13

A combined total of 78% of all grower respondents across the three surveyed winter grower seminars indicated that they used some form of planting-time insecticide protection to manage insect pests in 2025 (Table 7). Although that was slightly lower than the two previous years (i.e., 84 and 82% for 2023 and 2024, respectively), no major trend can be determined because, due to a technical issue at the Grafton seminar, no data was collected for the 2025 crop year. The majority (40%) of respondents from all grower seminar locations reported that they planted seed treated with Poncho Beta insecticidal seed treatment in 2025, which was comparable to the overall use rate of Poncho Beta-treated seed during the 2023 and 2024 growing seasons (36 and 38%, respectively). An average of 16% 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 (11%) or Mustang Maxx (6%), or they used either Cruiser (1%) or NipsIt Inside (4%) seed treatment, all of which were very similar to the usage rates of those products in 2023 and 2024. The majority of planting-time insecticide use in 2025 was carried out by growers that attended the Fargo and Grand Forks seminars, at which 92 and 97% of respondents, respectively, reported using some form of planting-time insecticide protection in 2025. Substantially lower numbers (i.e., 48% overall) of Wahpeton seminar respondents responded as having used an insecticide at planting.

Table 7. *Planting-time* insecticide use for sugarbeet insect pest management in 2025

Location	Number of responses	Counter 20G	Midac FC	Mustang Maxx	Poncho Beta	Cruiser	NipsIt Inside	Other	None
		---% of responses---							
Fargo	24	17	4	4	58	0	4	4	8
Grand Forks	66	18	20	3	48	2	6	0	3
Wahpeton	52	13	2	12	21	0	0	0	52
Totals	142	16	11	6	40	1	4	1	22

At the Fargo seminar, 58% of producers reported using Poncho Beta insecticidal seed treatment for at-plant protection from insect pests in 2025, which was a 13.6% increase compared to the previous year and a continued upward trend of increased Poncho Beta usage, because there had been a 33% increase in reported use of that product between 2023 and 2024. An additional 17% of Fargo attendees applied Counter 20G for at-plant protection from insect pests, which amounted to a 45% decrease in use of Counter 20G for those producers when compared to that reported for 2024. Other reported at-plant insecticide usage by Fargo attendees in 2025 included Mustang Maxx, Midac FC, and NipsIt Inside insecticidal seed treatment, which were each reported as being used by 4% of Fargo).

At the Grand Forks seminar location, 48% of respondents reported that they used Poncho Beta-treated seed for at-plant insect control, and NipsIt Inside-treated seed was used by 6% of respondents. Counter 20G was reported as being used at planting by 18% of grower respondents at Grand Forks, which was very similar to the reported use of Counter by Grand Forks respondents in 2023 and 2024, but lower than the use of that insecticide in 2022. Midac FC was reported as being used at planting by 20% of Grand Forks respondents in 2025, which was comparable to the reported use of Midac in 2023 (17%) and 2024 (19%). Use of Mustang Maxx in 2025, as reported by Grand Forks respondents, was at 3%, which was identical to reported use of Mustang Maxx in 2024.

At the Wahpeton seminar location, 12% of respondents indicated that they had applied Mustang Maxx for planting-time protection from insect pests in 2025, which was a 50% increase from reported Mustang usage in 2024, but about the same as was reported for the 2023 growing season. Just 13% of Wahpeton attendees reported using a planting-time application of Counter 20G for insecticide protection in 2025, which was nearly identical to the reported usage of the insecticide in 2024. An additional 21% of Wahpeton attendees reported that they used Poncho Beta-treated seed for insect pest management in 2025, which was a 33% increase from reported use of that seed treatment insecticide in 2024. Only 2 percent of Wahpeton respondents reported using Midac FC for a planting-time insecticide in 2025, which was comparable to the reported use in the area during the previous two growing seasons.

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 2025 (Table 8). That usage rate was identical to the reported rate in 2024. Thimet 20G was used by just 4% of grower respondents, as averaged across all seminar locations. The majority of Fargo (76%), Grand Forks (73%), and Wahpeton (77%) respondents reported no use of a granular insecticide in 2025, which reflected a general reduction (i.e., a 7% decrease) in at-plant insecticide usage throughout the production area.

About 58% of the Fargo respondents that did use a granular insecticide applied Counter 20G at the 7.5-lb application rate and about 21% used the 7.5-lb rate; but no Fargo seminar respondents reported applying Counter 20G at its high (8.9 lb product/ac) labeled rate in 2025.

Table 8. Application rates of *granular* insecticides used for sugarbeet insect pest management in 2025

Location	Number of responses	Counter 20G			Thimet 20G		Other	None
		8.9 lb	7.5 lb	5.25 lb	7 lb	4.5 lb		
		---% of responses---						
Fargo	21	0	14	5	0	0	5	76
Grand Forks	41	10	10	5	0	0	2	73
Wahpeton	48	0	8	8	0	2	4	77
Totals	110	1	13	5	2	2	4	75

At the Grand Forks grower seminar, 27% of respondents reported using a granular insecticide at planting in 2025, which down slightly from 33% as reported by Grand Forks respondents in 2024. Of the Grand Forks attendees that used a granular insecticide at planting in 2025, Counter 20G was used by the same proportion (i.e., 37% each) at the 7.5- and 8.9-lb rates, whereas, just 5 of 27 total (i.e., 18.5%) reported users of a granular insecticide applied Counter 20G at the low labeled rate of 5.25 lb product per acre.

Use of granular insecticides by Wahpeton seminar attendees (23% of respondents, as compared to 20% of Wahpeton respondents in 2024) was low in comparison to responses at the other seminar locations. Most of the Wahpeton seminar respondents who reported using a granular insecticide at planting in 2025 used Counter 20G at either 7.5 or 5.25 lb product per acre (i.e., 34.8% of respondents for each rate).

Averaged across the Fargo, Grand Forks, and Wahpeton survey locations, 25% of respondents reported using a postemergence insecticide to manage the sugarbeet root maggot (SBRM) in 2025 (Table 9). That usage rate reflected a 32 to 34% reduction in reported usage for this purpose from those reported for the 2023 and 2024 growing seasons. At the Fargo seminar site, 10% of respondents reported that they had applied Mustang Maxx for postemergence root maggot control in 2025, which was a significant reduction in usage from 33% of respondents for the 2023 crop year and 25% of reporting growers for the 2024 crop year. That decline was likely influenced by the reinstatement of chlorpyrifos registration for use in sugarbeet that began in 2024. This is supported by the fact that 10% of Fargo respondents reported using a chlorpyrifos-containing postemergence insecticide for SBRM management in 2025. Interestingly, 5% of Fargo attendees reported using Counter 20G for root maggot management in 2025. No other postemergence insecticide use was reported by Fargo seminar attendees for the 2025 growing season.

A total of 37% of Grand Forks seminar attendees reported using a postemergence insecticide for root maggot management in 2025, which was similar to the reported use for this purpose during the 2023 and 2024 growing seasons (40 and 41% usage, respectively). About 65% 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 just 5% used Mustang Maxx, and an additional 5% each used either Counter 20G or Thimet 20G for this purpose in 2025. About 16% of the Wahpeton seminar attendees reported using a postemergence-applied insecticide for SBRM control in 2025, which was an increase from 9% of Wahpeton respondents for the 2024 crop year. Of the Wahpeton respondents that used a postemergence insecticide for SBRM control, 25% reported using a chlorpyrifos insecticide product, 25% indicated that they had used Mustang Maxx, 13% responded as having applied Thimet 20G, and the remaining 38% reported applying a product that was not included as a choice for this question.

Table 9. *Postemergence* insecticide use for *sugarbeet root maggot* management in 2025

Location	Number of responses	Asana XL	Chlorpyrifos	Mustang Maxx	Counter 20G	Thimet 20G	Other	None
		---% of responses---						
Fargo	22	0	10	10	5	0	0	75
Grand Forks	40	2	24	2	2	2	2	63
Wahpeton	50	0	4	4	0	2	6	84
Totals	112	1	13	5	2	2	4	75

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 2025 as good to excellent (Table 10). An average of 6% of growers that attended the 2025 seminars rated the SBRM control performance of their insecticide program as being fair, and none of respondents across locations viewed their insecticide performance as poor for this purpose. An additional 13% of attendees across all grower seminar locations responded as being unsure of the success of their control programs for SBRM control.

Table 10. *Satisfaction* with insecticide treatments for sugarbeet root maggot management in 2025

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		----------% of responses----------				
Fargo	22	50	38	0	0	13
Grand Forks	40	13	73	7	0	7
Wahpeton	50	20	40	10	0	30
Totals	112	21	60	6	0	13

Individually, grower satisfaction with insecticide performance for root maggot control in 2025 was rated as good to excellent by 88, 86, and 60% of Fargo, Grand Forks, and Wahpeton respondents, respectively. Satisfaction with insecticide performance for SBRM control was rated as fair by 0, 7, and 10% of respective respondents at the Fargo, Grand Forks, and Wahpeton seminar locations. There were no reports of poor insecticide performance for SBRM control during the 2025 growing season at any of the grower seminar locations.

As presented in Table 11, a combined average of 55% of grower respondents at the Fargo, Grand Forks, and Wahpeton grower seminar locations used an insecticide for planting-time protection against springtails in 2025, which was about the same as reported for this use in 2023 (60%) and 2024 (58%). The majority (58%) of respondents that applied an insecticide for this purpose in 2025, as averaged across all seminar locations, planted seed treated with Poncho Beta insecticide. An additional 22% of the growers that used a planting-time insecticide for springtail control in 2025 used Counter 20G, which was very similar to the use rates of that product for springtail control in 2023 and 2024 (20% of respondents for both previous years). An additional 15% of producers that deployed insecticidal protection for springtail management applied Midac FC for this purpose, which was about that same as the usage rate for Midac in 2024 (17%), and about double the use rate reported for the 2023 growing season.

Table 11. Insecticide use for *springtail* management in 2025

Location	Number of responses	Poncho Beta	Cruiser	NipsIt Inside	Midac FC	Mustang Maxx	Counter 20G	Other	None
		----------% of responses----------							
Fargo	21	43	0	0	0	0	24	0	33
Grand Forks	53	43	2	6	17	2	13	0	17
Wahpeton	56	16	0	0	2	2	5	0	75
Totals	130	32	1	2	8	2	12	0	45

A relatively small portion (5%) of total respondents, as reported across all seminar locations, used Mustang Maxx for springtail control, and 55% of growers across all locations reported no insecticide use for springtail control, which was a slight increase in producers opting to forgo a springtail control product in 2023 and 2024.

At the Fargo seminar, Poncho Beta and Counter 20G were reported as being used for springtail control by 43 and 24% of respondents, respectively. There was no other reported insecticide use for springtail management by Fargo grower seminar respondents.

Grand Forks seminar respondents reported the highest incidence of insecticide use for springtail management, with 83% reporting use of some form of insecticidal protection in their sugarbeet crop. A large majority (23 of 44 individuals; 52%) of Grand Forks grower respondents who used an insecticide for springtail control indicated that they used Poncho Beta insecticide-treated seed for this purpose during the 2025 growing season. That figure was very similar to the usage rates reported by Grand Forks attendees for the 2023 and 2024 growing seasons (i.e., 52 and 54%, respectively). 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 total respondents) or Counter 20G (13% of respondents), and those patterns were also similar to those reported for 2024.

Results from the Wahpeton seminar survey indicated that 25% of respondents used some form of insecticide protection at planting time for springtail in 2025, which was an increase from 2024 when 16% of respondents reported using an insecticide at planting for this purpose. Of those respondents, 64% (9 of 14 respondents) indicated that they used Poncho Beta, 21% used Counter 20G, and Midac FC and Mustang Maxx were reported as being used by 7% of respondents each for this purpose in 2025.

As shown in Table 12, an overall average of 68% of grower respondents surveyed at the Fargo, Grand Forks, and Wahpeton grower seminars rated their insecticide performance for springtail management in 2025 as good to excellent, and only 2% of respondents across all seminar locations viewed their insecticide performance for this purpose as poor. The majority (77%) of Fargo seminar attendees rated their insecticide performance for springtail control as good to excellent, which was a significant increase over responses in the previous report on the 2024 growing season. An additional 15% viewed the performance of their springtail management practice in 2025 as fair, but that was down considerably from 25% of respondents assessing their 2024 springtail control success as fair. No Fargo respondents viewed their springtail management success as poor in 2025, but 18% of them indicated that they were not sure about the effectiveness of their insecticide product for this purpose.

Table 12. *Satisfaction* with insecticide treatments for springtail management in 2025

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		----------% of responses----------				
Fargo	19	23	54	15	0	8
Grand Forks	43	35	32	12	3	18
Wahpeton	52	25	33	0	0	42
Totals	114	31	37	10	2	20

At the Grand Forks seminar, 67% of respondents viewed their springtail control in 2025 as being good to excellent, which was an increase from 61% for the 2024 growing season. About 12% of Grand Forks respondents rated their satisfaction with springtail management as fair, and an additional 3% viewed it as poor.

Survey results from the Wahpeton seminar location indicated that 58% of grower respondents viewed their springtail control as being either good or excellent, which was down from 66% for the 2024 crop year. Interestingly, 42% of Wahpeton respondents were unsure of the level of springtail control success they had achieved in 2025, which was a substantial increase from 19% of Wahpeton respondents being uncertain about their springtail control success for the 2024 growing season.

Lygus bugs were not a major production problem for Red River Valley producers in 2025. This was evidenced by our observation that about 97% of grower respondents, averaged across the Fargo, Grand Forks, and Wahpeton grower seminars, indicated that they did not employ an insecticide for Lygus bug control (Table 13). Survey results from the Fargo and Wahpeton winter grower seminars indicated that only 5 and 2% of respondents, respectively used an insecticide for Lygus bug control in 2025, and 100% of that usage involved Mustang Maxx applications. Similarly, just 3% of Grand Forks respondents reported using an insecticide for Lygus bug control, and 100% of those applications were made with Asana XL. In contrast, however, 39% of producers representing the Southern Minnesota Beet Sugar Cooperative growing area at the Willmar seminar indicated that they had used an insecticide for Lygus bug control in 2024. Twenty-one percent of Willmar respondents overall, which was 58% of the growers who indicated using an insecticide for Lygus bug management at that seminar, reported using Asana XL for this purpose. An additional 12% of Willmar respondents, or about 31% of growers that chose to use an insecticide, selected Mustang Maxx for their Lygus bug control in 2025

Table 13. Insecticide use for Lygus *bug* management in 2025

Location	Number of responses	Asana XL	Dibrom	Movento	Mustang Maxx	Transform	Other	None
		----------% of responses----------						
Fargo	20	0	0	0	5	0	0	95
Grand Forks	39	3	0	0	0	0	0	97
Wahpeton	48	0	0	0	2	0	0	98
Willmar	66	21	0	0	12	0	4	61
Totals	173	9	0	0	6	0	2	83

Survey results on satisfaction with insecticide performance for Lygus bug control are presented in Table 14. As was the case in previous reports, these results should be interpreted with discretion because the exceptionally low frequency of insecticide use for that purpose resulted in a very small sample size. Averaged across all seminar locations, 69% of respondents viewed the performance of their insecticide for Lygus bug control in 2025 as good to excellent; however, 24% of them were unsure.

There was only one response to this question at the Fargo seminar, and just two responses at Grand Forks; however, all of those respondents rated their Lygus control as good to excellent. Only two responses were received for this question at the Wahpeton seminar, but both indicated that the respondents were unsure of the success of their Lygus bug control efforts. At the Willmar grower seminar, 71% of grower respondents assessed the performance of the insecticide they applied for Lygus bug control as good to excellent. About 4% of the grower respondents at the Willmar seminar assessed their Lygus control as fair, and an equal proportion viewed it as poor. The remaining 24% of Willmar respondents were unsure of the effectiveness of their Lygus bug control.

Table 14. *Satisfaction* with insecticide treatments for Lygus *bug* management in 2025

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		----------% of responses----------				
Fargo	19	100	0	0	0	0
Grand Forks	38	50	50	0	0	0
Wahpeton	49	0	0	0	0	100
Willmar	68	29	42	4	4	21
Totals	174	31	38	3	3	24

Grasshoppers were not a widespread issue for area sugarbeet producers in 2025, which was evidenced by the overall average of 86% of respondents across all seminar locations reporting that they did not use any insecticide for this purpose (Table 15). Although only 10% of Fargo seminar attendees indicated that they used an insecticide for grasshopper control in 2025, one half of those respondents reported using Mustang Maxx and one half of them used a chlorpyrifos-based insecticide product for that purpose in 2025. Slightly more insecticide use for grasshopper control was reported by Grand Forks seminar attendees (17% of respondents overall). The majority of insecticide use by Grand Forks attendees involved either a chlorpyrifos-containing insecticide product (7% of respondents) or Mustang Maxx (5% of respondents), although minor use of Asana XL and Vantacor (2% of respondents each) was also reported. Responses to this question at the Wahpeton seminar location indicated that about 14% of growers used an insecticide to manage grasshoppers in 2025. Mustang Maxx was reported as the most frequently used insecticide for grasshopper control by Wahpeton attendees, although only 10% of Wahpeton respondents overall used the insecticide for this purpose. An additional 4% of Wahpeton respondents indicated that they used a chlorpyrifos-based insecticide product for this purpose.

Table 15. Insecticide use for *grasshopper* management in 2025

Location	Number of responses	Asana XL	Chlor-pyrifos	Dibrom	Mustang Maxx	Vantacor	Other	None
		----------% of responses----------						
Fargo	12	5	5	0	0	0	0	90
Grand Forks	42	2	7	0	5	2	0	83
Wahpeton	51	0	4	0	10	0	0	86
Totals	114	2	5	0	6	1	0	86

Good to excellent grasshopper control in 2025 was reported by 92% of all respondents that attended the three winter grower seminar locations in 2026, and the remaining 8% indicated that they were unsure of their insecticide performance success (Table 16). At the Fargo winter grower seminar, 100% of respondents that used an insecticide for this purpose rated it as having provided excellent grasshopper control in 2025. Similarly, 50% of respondents at the Grand Forks grower seminar viewed their insecticide performance in managing grasshopper infestations as being excellent, and the remaining 50% of respondents rated their grasshopper control as good. Results from the Wahpeton grower seminar indicated that 84% of growers that used an insecticide for grasshopper control in 2025 viewed its performance as good to excellent, and 18% of respondents were unsure of the effectiveness of their insecticide for this purpose in 2025.

Table 16. *Satisfaction* with insecticide treatments for *grasshopper* management in 2025

Location	Number of responses	Excellent	Good	Fair	Poor	Unsure
		----------% of responses----------				
Fargo	19	100	0	0	0	0
Grand Forks	38	50	50	0	0	0
Wahpeton	50	17	67	0	0	17
Totals	107	42	50	0	0	8

As in past years, the 2025 winter sugarbeet grower seminar attendees were asked about how their insecticide use for insect pest management compared to previous years. Overall, 68% of respondents at all (Fargo, Grand Forks, Wahpeton, and Willmar) seminar locations combined reported that their insecticide usage in 2025 did not differ from that of the previous five years (Table 17). The most significant insecticide use change throughout the growing area, as observed with responses to this question, was that 13% of producers reported using less insecticide in 2025 than in the previous five years. Interestingly, 14% of Fargo respondents and 25% of Willmar respondents indicated that their insecticide use decreased in comparison to the past five years, whereas only 5% of Fargo and Grand Forks respondents indicated an increase in insecticide use during the 2025 growing season. Similarly, just 4% of Willmar survey respondents reported increased insecticide use in 2025.

Table 17. Insecticide use in sugarbeet during 2025 compared to the previous 5 years

Location	Number of responses	Increased	Decreased	No Change	No Insecticide Use
		----------% of responses----------			
Fargo	22	5	14	73	9
Grand Forks	42	5	2	90	2
Wahpeton	50	0	4	68	28
Willmar	72	4	25	53	18
Totals	186	3	13	68	16

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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 2025

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Sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), fly activity was monitored at 125 grower field sites throughout the Red River Valley during the 2025 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.

Sticky trap capture rates suggested that SBRM fly activity in the Red River Valley in 2025 was substantially higher than that recorded in 2024, but slightly lower than activity recorded during several of the previous years (Figure 1). As is usually the case, the most intense SBRM fly activity observed in 2025 occurred in central and northern portions of the Red River Valley; however, high activity levels were also recorded in fields near Ada, Borup, and Sabin, MN.

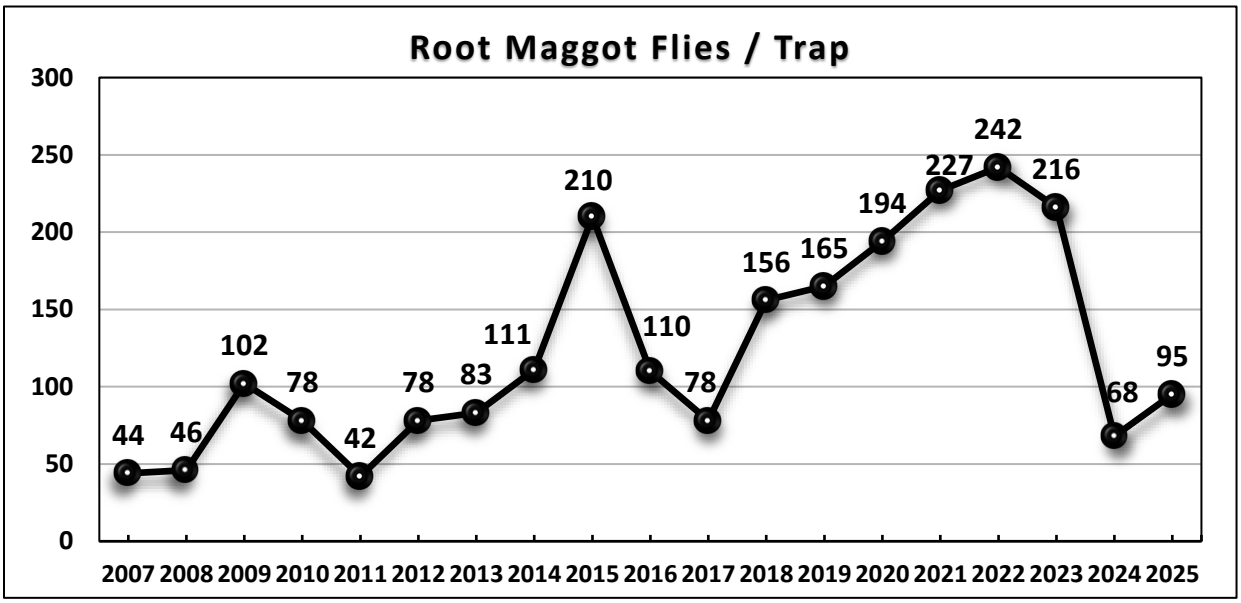

Figure 1. Yearly averages of sugarbeet root maggot flies captured on sticky-stake traps (Blickenstaff and Peckenpaugh, 1976) in the Red River Valley from 2007 to 2025.

High to severe levels of SBRM fly activity (i.e., cumulative captures of at least 200 flies per sticky stake) were observed in 2025 in fields near the following communities (cumulative flies per stake in parentheses): Auburn (329), Bowesmont (317), Buxton (405), Cashel (742), Nash (274), Reynolds (556), St. Thomas (510), and Veseleyville (240), ND, as well as in fields near Ada (301), Borup (723), Eldred (215), Lockhart (100), Sabin (244), and Stephen, MN (258).

Moderately high levels of activity (i.e., cumulative captures of between 43 and 199 flies per sticky stake) were also recorded near Bathgate, Cavalier, Crystal, Grafton, Grand Forks, Hamilton, Hoople, Manvel, and Oakwood, ND, and near Crookston, East Grand Forks, Euclid, Hadler, Hallock, Key West, Oslo, and Tabor, MN. Fly activity was either considered economically insignificant or was undetectable in most other areas during 2025.

Figure 2 presents SBRM fly monitoring results from three representative sites (i.e., Cashel and Reynolds, ND, and Borup, MN) during the 2025 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 6, which was about one week earlier than the historical average.

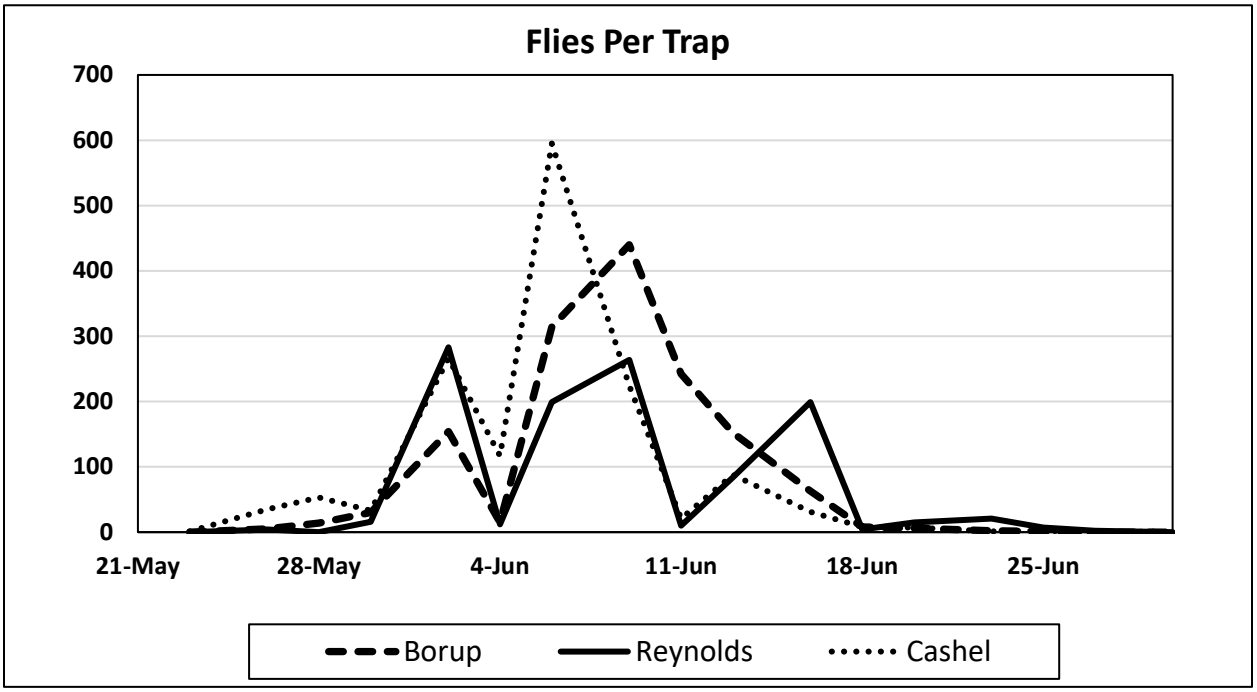

Fig. 2. Sugarbeet root maggot flies captured on sticky-stake traps at selected Red River Valley sites, 2025.

In late-August and early September of 2025, after the sugarbeet root maggot larval feeding period had ended, 30 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 in those locations. 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) in 2025, averaged 2.13 on the 0 to 9 rating scale, which amounted to a 29% decrease over that recorded in 2024. This suggests that, despite a slight increase in root maggot fly activity in 2025, many sugarbeet producers were successful in protecting their fields from larval injury to sugarbeet roots. 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 42 flies/trap near Crookston, MN to 1,483 flies/trap near Cashel, ND.

Table 1. Sugarbeet root maggot fly activity and larval feeding injury in Red River Valley commercial sugarbeet fields where injury exceeded 2.5 on the 0 to 9 rating scale, 2025

Nearest City	Township	State	Flies/stake	Average Root Injury Rating[a]
Auburn	Farmington	ND	329	4.8
Cashel	Martin	ND	742	3.3
Sabin	Elmwood	MN	244	3.1
Lockhart	Lockhart	MN	100	2.9
Crystal	Elora	ND	258	2.7
Stephen	Augsburg	MN	240	2.7
Veseleyville	Ops	ND	82	2.7
Donaldson	Spring Brook	MN	36	2.7
Eldred	Roome	MN	53	2.7
Bowesmont	Lincoln West	ND	317	2.6
Crookston	Andover	MN	21	2.6
Thompson	Walle	ND	32	2.6

[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).

Risk of economically threatening levels of root maggot fly activity will be highest in 2026 in areas where high fly activity was observed in 2025. Moreover, the greatest risk will be in close proximity to fields where the highest levels of SBRM larval feeding injury were observed in 2025. Accordingly, growers in those areas should plan an appropriate SBRM management plan to avoid serious economic loss.

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 2026. 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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SUGARBEET ROOT MAGGOT FORECAST FOR THE 2026 GROWING SEASON

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The 2026 risk map for sugarbeet root maggot (SBRM) fly activity in the Red River Valley appears in the figure below. Although root maggot fly activity had been lower in 2024 when compared to several of the previous years, population levels increased slightly in 2025. The results of followup ratings of SBRM feeding injury in growers' fields suggested that, despite the modest increase in SBRM flight activity, fields sustained slightly lower root maggot damage than had been observed in 2024. Nonetheless, several areas are still at moderate to high risk of economic loss from this perennial pest.

Areas at highest risk of economically damaging SBRM infestations in 2025 will include rural Auburn, Bowesmont, Buxton, Nash, Reynolds, St. Thomas, and Veseleyville, ND, as well as Ada, Eldred, Rockwell, Sabin, and Stephen, MN (see figure below). Moderate risk of significant SBRM feeding injury is expected in areas bordering high-risk zones, as well as fields near Bathgate, Cavalier, Crystal, Grafton, Grand Forks, Hamilton, Hoople, Manvel, Oakwood, and Thompson, ND, as well as Borup, Crookston, Donaldson, East Grand Forks, Euclid, Key West, Hadler, Hallock, Oslo, and Tabor, MN. The remainder of the production area is at low risk from this pest.

Proximity to previous-year beet fields where populations were high and/or control was unsatisfactory increases risk. Areas where high fly activity occurred in 2025 should be monitored closely in 2026. Sugarbeet growers in high-risk areas should use an aggressive insecticidal approach to SBRM control and also anticipate needing to apply a postemergence rescue insecticide. Growers in moderate-risk areas using insecticidal seed treatments for at-plant protection should monitor fly activity levels 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.

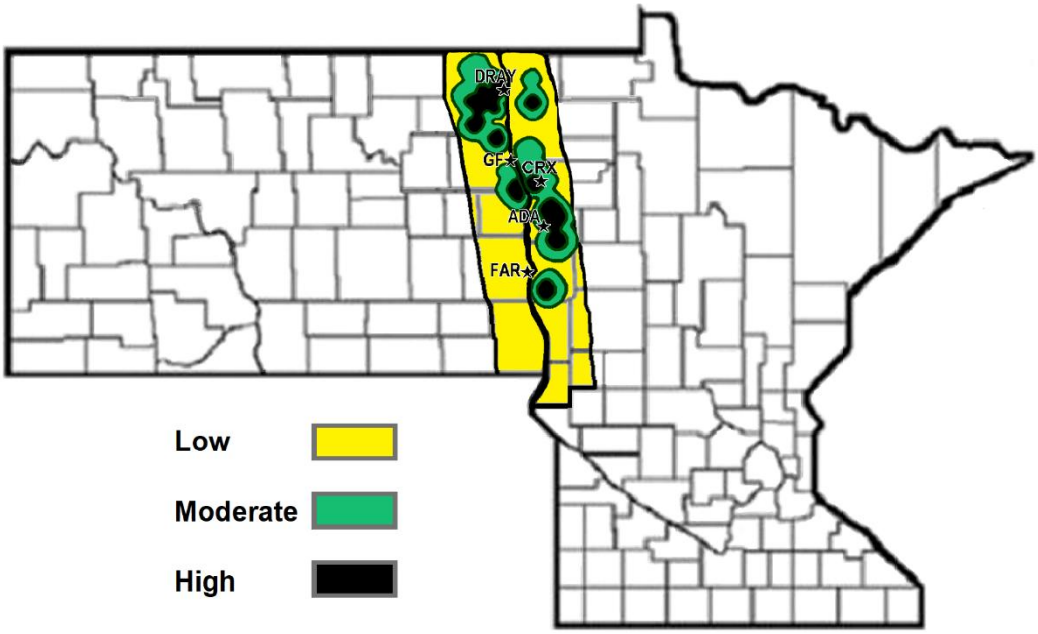

Fig. 1. Anticipated risk of SBRM fly activity and damaging larval infestations in the Red River Valley.

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AT-PLANT AND POSTEMERGENCE INSECTICIDE COMBINATIONS TO MANAGE SUGARBEET ROOT MAGGOT

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the most economically damaging insect pest of sugarbeet in central and northern portions of the Red River Valley (RRV) of North Dakota and Minnesota. Previous research has shown that this insect is capable of causing more than 45% yield losses in the absence of effective control measures (Boetel et al. 2010). Sugarbeet root maggot management programs in areas at high risk of economic loss from this pest usually consist of planting-time protection, in the form of a granular, liquid, and/or seed treatment insecticide, followed by an additive postemergence insecticide application (i.e., either a granular or sprayable liquid product) when the SBRM infestation level warrants such action. Postemergence liquid insecticide treatments, applied on an as-needed, rescue basis, are the most commonly used postemergence tools for SBRM control in the region. An advantage of postemergence sprays is that they allow growers to use a "wait and see" approach to make informed decisions on whether rescue insecticide treatments are needed based on current SBRM fly activity levels in their fields. This project involved two experiments with a common overall objective of developing effective strategies to combine planting-time and postemergence insecticide tools for improving growers' ability to protect fields from sugarbeet root maggot feeding injury while also optimizing sugarbeet yield, quality, and economic return.

Materials and Methods:

Both of these experiments were conducted on a commercial sugarbeet field site near St. Thomas (Pembina County), ND during the 2025 growing season. Betaseed 8018 glyphosate-resistant seed (with or without Poncho Beta insecticidal seed treatment, depending on the experiment) was used for both experiments. Both experiments were planted on May 6, 2025. All plots were planted using a 6-row Monosem NG Plus 4 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. No insecticide was applied to the outer "guard" rows (i.e., rows one and six) of each plot, as those rows served as untreated buffers. Each plot was 35 feet long, and 35-foot alleys between replicates were maintained weed-free throughout the growing season by using tillage operations. Both experiments were arranged in a randomized complete block design with four replications of the treatments.

Planting-time insecticide applications: Counter 20G was applied in both trials 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 a planter-mounted SmartBox™ computer-controlled insecticide delivery system that was calibrated on the planter immediately before all applications.

Postemergence insecticide applications: Postemergence insecticides consisted of two granular materials (i.e., Counter 20G and Thimet 20G) that were both band-applied (Post B) on June 2 (i.e., 5 days before peak SBRM fly activity). Delivery of postemergence banded granules was achieved by using Kinze™ row banders attached to a tractor-mounted tool bar and adjusted to a height to deliver the insecticides in 4-inch bands. Similar to at-plant insecticide applications, postemergence granular output rates were also regulated by using a SmartBox™ system mounted on a tractor-drawn four-row toolbar. Granules were incorporated by using two pairs of rotary tines that straddled each row on the tool bar. A paired set of tines was positioned ahead of each bander, and a second pair was mounted behind the granular drop zone of each row unit. This system effectively stirred soil around the bases of sugarbeet seedlings and incorporated granules as the unit passed through each plot.

All postemergence sprayable liquid applications in these two experiments were delivered as broadcasts. All applications of Pilot 4E in Study I were made on June 4 (i.e., 3 days before SBRM peak fly activity). Single applications of Pilot 4E and Mustang Maxx in Study II were applied on June 5 (i.e., 2 days before peak fly), whereas, split applications of Pilot 4E in were made 10 days apart on June 3 and 13 (i.e., 4 days before and 6 days after SBRM peak fly activity). Sprays were applied from a tractor-mounted CO_2-propelled spray system equipped with an 11-ft boom that was calibrated to deliver a finished spray output volume of 10 GPA through TeeJet™ 11001VS nozzles.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed for these experiments on August 7 (Study I) and August 11 (Study II). Rating procedures consisted of randomly collecting ten sugarbeet roots (i.e., five from each of the outer two treated rows) per plot, hand-washing them in a bucket of water, and scoring each 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 8, and Study II was harvested on October 2. 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 root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute 2025), 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. Results from sugarbeet root maggot feeding injury ratings for Study I are presented in Table 1. The level of root injury sustained by roots in the untreated check plots (mean = 5.93 on the 0 to 9 scale of Campbell et al. [2000]) suggested that a moderate SBRM infestation was present for the experiment. Significantly lower levels of SBRM feeding injury were recorded in all insecticide-protected treatments in Study I when compared to the untreated check. This showed that all insecticide treatments, including the stand-alone treatments of either Counter 20G or Poncho Beta seed treatment, as well as the multiple-component insecticide combinations, provided significant levels of protection from SBRM feeding injury.

The greatest root protection (i.e., lowest overall SBRM larval injury) in Study I occurred in plots treated at planting with Counter 20G at its high (8.9 lb product/ac) rate, then subsequently treated with a dual postemergence insecticide program comprised of Thimet 20G at its high rate (7 lb product per acre, applied 5 days before SBRM peak fly activity) that was followed by a broadcast spray of Pilot 4E at its maximum labeled rate of 2 pts of product per acre at 3 days pre-peak. Although that treatment sustained the lowest average SBRM feeding injury, it was not statistically superior to the following entries that also provided excellent root protection:

1) Counter 20G (7.5 lb/ac, at-plant band) + Thimet (7 lb/ac, 5d pre-peak) + Pilot 4E (2 pts/ac, 3d pre-peak;
2) Poncho Beta + Counter 20G (8.9 lb/ac, at-plant band) + Thimet (7 lb/ac banded, 5d before peak); and
3) Counter 20G (8.9 lb/ac, at-plant band) + Thimet (7 lb/ac banded, 5d before peak)

The remaining entries in this experiment performed at similar levels with respect to protection from root maggot feeding injury, irrespective of whether comprised of single, dual, or multi-component treatments. The relative infrequency of statistically significant differences in SBRM feeding injury among treatments in this experiment could either be a result of inter-plot variability or an artifact of the moderate root maggot infestation that developed in the plot area.

Table 1. *Larval feeding injury* in an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence insecticides, for sugarbeet root maggot control, St. Thomas, ND, 2025 (Study I)

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	8.9 lb 7 lb 2 pts	1.8 1.4 1.0	2.95 d
Counter 20G + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	7.5 lb 7 lb 2 pts	1.5 1.4 1.0	3.40 cd
Poncho Beta + Counter 20G + Thimet 20G	Seed B 5 d Pre-peak Post B	 8.9 lb 7 lb	68 g a.i./ unit seed 1.8 1.4	3.60 bcd
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	4.00 bcd
Poncho Beta + Counter 20G + Thimet 20G	Seed B 3 d Pre-peak Post B	 7.5 lb 7 lb	68 g a.i./ unit seed 1.5 1.4	4.10 bc
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	4.25 bc
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	4.30 bc
Poncho Beta	Seed		68 g a.i./ unit seed	4.40 bc
Poncho Beta + Thimet 20G + Pilot 4E	Seed 5 d Pre-peak Post B 3 d Pre-peak Post B	 7 lb 2 pts	68 g a.i./ unit seed 1.4 1.0	4.45 bc
Counter 20G	B	8.9 lb	1.8	4.60 b
Poncho Beta + Thimet 20G +	Seed 5 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	4.70 b
Check	---	----	---	5.93 a
LSD (0.05)				

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 band; Post B = 4-inch postemergence band; Seed = insecticidal seed treatment

Yield data from Study I are presented in Table 2. Most insecticide treatments in this experiment resulted in statistically significant increases in recoverable sucrose yield when compared to the untreated check. The highest recoverable sucrose yield in this trial was produced by plots treated at planting with Counter 20G at its moderate (7.5 lb product/ac) rate, then subsequently treated with a dual postemergence insecticide program comprised of Thimet 20G at its high rate (7 lb product per acre, applied 5 days before SBRM peak fly activity) and a broadcast spray of Pilot 4E at its maximum labeled rate of 2 pts of product per acre at 3 days pre-peak. This top performer in the trial generated a gross revenue (not including product or application costs) of $2,036 per acre, which was $522/ac greater gross economic return than that recorded for the untreated check.

The following entries in Study I also provided excellent yields and gross economic returns, and were not statistically outperformed in relation to sucrose yield or root tonnage by the aforementioned top-performing treatment (i.e., Counter 20G at planting [7.5 lb/ac] + Thimet 20G [5d before peak fly, 7 lb/ac] + Pilot 4E [2 pts/ac, 3d pre-peak]):

1) Poncho Beta + Counter 20G (8.9 lb/ac, banded at planting) + Thimet 20G (7 lb/ac, 2d before peak fly);
2) Poncho Beta + Thimet 20G (7 lb/ac, 2d before peak fly) + Pilot 4E (2 pts/ac, 3d pre-peak;
3) Counter 20G (8.9 lb/ac, banded at planting) + Thimet 20G (7 lb/ac, 5d before peak fly);
4) Poncho Beta + Counter 20G (8.9 lb/ac, banded at planting); and
5) Poncho Beta.

Although these control programs resulted in numerically lower gross economic return than the aforementioned top-yielding treatment, they still generated between $335 and $490/ac more gross revenue than that recorded for the untreated check plots. Additionally, these revenue increases would have easily paid for the product and application costs associated with their use, and also would have provided excellent net returns in revenue per acre for a producer.

Table 2. *Yield parameters* from an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence insecticides, for sugarbeet root maggot control, St. Thomas, ND, 2025 (Study I)

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 + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	7.5 lb 7 lb 2 pts	1.5 1.4 1.0	13,377 a	38.9 a	18.27 a	2,036
Poncho Beta + Counter 20G + Thimet 20G	Seed B 5 d Pre-peak Post B	 8.9 lb 7 lb	68 g a.i./ unit seed 1.8 1.4	13,374 a	39.4 a	18.12 a	2,004
Poncho Beta + Thimet 20G + Pilot 4E	Seed 5 d Pre-peak Post B 3 d Pre-peak Post B	 7 lb 2 pts	68 g a.i./ unit seed 1.4 1.0	13,139 a	38.4 a	18.24 a	1,990
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	12,866 ab	37.5 a	18.31 a	1,951
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	12,797 ab	37.1 ab	18.39 a	1,957
Poncho Beta	Seed		68 g a.i./ unit seed	12,662 ab	37.9 a	17.98 a	1,849
Counter 20G + Thimet 20G + Pilot 4E	B 5 d Pre-peak Post B 3 d Post-peak Broadcast	8.9 lb 7 lb 2 pts	1.8 1.4 1.0	11,761 bc	33.4 bc	18.68 a	1,849
Poncho Beta + Counter 20G + Thimet 20G	Seed B 3 d Pre-peak Post B	 7.5 lb 7 lb	68 g a.i./ unit seed 1.5 1.4	11,550 bc	33.4 bc	18.40 a	1,776
Counter 20G + Thimet 20G +	B 5 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	11,075 cd	32.4 cd	18.20 a	1,671
Poncho Beta + Thimet 20G +	Seed 5 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	10,863 cd	31.6 cd	18.28 a	1,657
Counter 20G	B	8.9 lb	1.8	10,417 cd	29.8 cd	18.60 a	1,621
Check	---	----	---	9,867 d	28.5 d	18.37 a	1,514
LSD (0.05)				1363.9	3.98	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 band; Post B = 4-inch postemergence band; Seed = insecticidal seed treatment

Root injury rating data in Study II also indicated that there was no major benefit by using split post-emergence applications of Pilot 4E, because there were no significant differences among either Counter 20G or Poncho Beta based treatment combinations when Pilot was applied either once at its full labeled rate (2 pts/ac) or the moderate rate of 1 pt product per acre. This suggests that, under moderate SBRM pressure such as that present for this study, input costs could be saved by simply making a well-timed single application of Pilot 4E or a similar postemergence sprayable liquid insecticide.

Trends in Study I indicated that, despite the relatively moderate SBRM infestation pressure, triple-component insecticide programs generated numerically more sucrose yield, root tonnage, and gross revenue than single-component programs, although the differences were not always statistically significant. Interestingly, in triple-component programs that involved Counter 20G at planting, followed by Thimet 20G and a follow-up application of Pilot 4E, applying the Counter at its moderate (7.5 lb/ac) rate resulted in statistically greater recoverable sucrose and root yields than when the Counter was applied at its high label rate of 8.9 lb product per acre. This was also the case with gross revenue returns, which were $187/ac greater when the at-plant application of Counter was made at the moderate rate instead of the maximum rate.

Study II. Similar to the results from Study I, evaluations of SBRM larval feeding injury in Study II indicated that a moderate SBRM infestation developed for this trial. This was supported by the moderate level of feeding injury (i.e., 6.25 rating on the 0 to 9 scale) recorded for the untreated check plots (Table 3). All insecticide-treated entries in Study II provided significant reductions in SBRM feeding injury when compared to the untreated check, however, there were very few significant differences in root protection among insecticide treatments.

The treatment combination involving Counter 20G applied at planting at its maximum labeled rate (8.9 lb product per acre) and combined with a single postemergence application of Pilot 4E at its high rate (2 pts/ac) provided the greatest level of protection from SBRM feeding injury (i.e., lowest root ratings) in Study II. However, that treatment was not statistically different from a similar combination that involved the same high (8.9-lb) rate of Counter at planting, combined with a postemergence application of Pilot at the lower rate of 1 pt product per acre.

Similarly, the aforementioned top-performing treatment combination of Counter at 8.9 lb plus Pilot at its high (2-pt) rate was not statistically different in regard to root protection against SBRM larval damage from the combination comprised of using Poncho Beta treated seed and following with a 2-pt application of Pilot 4E at postemergence. However, when the rate of Pilot 4E in the latter combination was reduced to 1 pint per acre, it allowed significantly greater SBRM feeding injury on roots.

Table 3. *Larval feeding injury* from an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence liquid insecticide sprays, for sugarbeet root maggot control, St. Thomas, ND, 2025 (Study II)

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	3.75 d
Counter 20G + Pilot 4E + Pilot 4E	B 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	4.28 cd
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	4.28 cd
Poncho Beta + Pilot 4E + Pilot 4E	Seed 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	 1 pt 1 pt	68 g a.i./ unit seed 0.5 0.5	4.33 bcd
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	4.33 bcd
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	4.45 bcd
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	4.68 bc
Poncho Beta	Seed		68 g a.i./ unit seed	4.88 bc
Counter 20G + Mustang Maxx	B 2 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	4.88 bc
Counter 20G	B	8.9 lb	1.8	5.13 bc
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	5.18 b
Check	---	----	---	6.25 a
LSD (0.05)				0.892

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; Seed = insecticidal seed treatment; Pre-Peak = before sugarbeet root maggot peak fly activity.

Yield results for Study II are presented in Table 4. Corresponding to the results from the SBRM feeding injury rating data, the yield analyses showed that nearly all insecticide programs provided significant increases in both recoverable sucrose yield and root tonnage in this trial.

One trend that was apparent in the yield data from this trial was that higher yields and gross revenues were generally more common in treatment combinations that involved Poncho Beta insecticide-treated seed as the at-plant component. For example, the highest overall recoverable sucrose yield in Study II was observed in plots initially protected at planting with Poncho Beta seed treatment plus a postemergence foliar application of Pilot 4E at its moderate (1 pt/ac) rate. Interestingly, that treatment combination produced numerically greater recoverable sucrose yield and root tonnage than a similar combination of Poncho Beta-treated seed that was followed by two postemergence applications of Pilot 4E, also applied at 1 pt/ac. That finding suggests two things. First, it indicates that, under moderate SBRM infestation levels such as that which developed for this trial, it may not be necessary to use the maximum rate of Pilot 4E (or a similar insecticide) to achieve excellent root maggot control while also producing excellent yields and revenue. Secondly, these results also suggest that a well-timed single postemergence insecticide spray can be sufficient for good control under moderate SBRM infestations. The only treatments that failed to result in significant recoverable sucrose and root yield increases in Study II were the stand-alone treatment of Counter 20G at its high (8.9 lb/ac) rate and the combination treatment of Counter 20G at its moderate (7.5-lb) rate plus a postemergence application of Pilot 4E, also applied at its respective moderate rate of 1 pt/ac.

The results of Studies I and II demonstrate the economic importance of the sugarbeet root maggot as an economic pest of sugarbeet in the Red River Valley. Economic benefits of effective SBRM management can easily exceed $500 per acre, even under moderate infestation levels. As such, the development implementation of effective control tools will continue to be critical to sustaining the profitability of sugarbeet production and

maximizing economic returns in areas affected by this pest. The overall results of these trials also show that, by combining at-plant insecticide protection involving either a granular insecticide such as Counter 20G or an insecticidal seed treatment (e.g., Poncho Beta, Cruiser, or NipsIt Inside), and combining it with a postemergence rescue insecticide (e.g., Thimet 20G or Pilot 4E) application can result in effective SBRM management and profitable sugarbeet production in areas affected by this pest.

Table 4. *Yield parameters* from an evaluation of planting-time insecticide granules or seed treatments, combined with postemergence liquid insecticide sprays, for sugarbeet root maggot control, St. Thomas, ND, 2025 (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)
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	12,744 a	38.6 ab	17.70 a	1,829
Poncho Beta + Pilot 4E + Pilot 4E	Seed 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	 1 pt 1 pt	68 g a.i./ unit seed 0.5 0.5	12,669 a	39.3 a	17.33 a	1,757
Poncho Beta + Pilot 4E	Seed 2 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	12,150 ab	37.2 abc	17.55 a	1,720
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	11,710 bc	34.8 c-f	17.93 a	1,728
Poncho Beta	Seed		68 g a.i./ unit seed	11,651 bcd	35.8 bcd	17.52 a	1,640
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	11,410 b-e	34.4 c-g	17.71 a	1,649
Counter 20G + Pilot 4E + Pilot 4E	B 4 d Pre-peak Broadcast 6 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	11,341 b-e	35.6 b-e	17.18 a	1,539
Counter 20G + Mustang Maxx	B 2 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	10,907 cde	32.6 e-h	17.93 a	1,600
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	10,707 de	32.2 fgh	17.80 a	1,557
Counter 20G + Pilot 4E	B 2 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	10,590 ef	31.4 gh	18.03 a	1,572
Counter 20G	B	8.9 lb	1.8	10,565 ef	32.8 d-h	17.34 a	1,458
Check	---	----	---	9,662 f	30.2 h	17.18 a	1,321
LSD (0.05)				958.1	3.17	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; Seed = insecticidal seed treatment; Pre-Peak = before sugarbeet root maggot peak fly activity.

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IMPACTS OF INSECTICIDE, FUNGICIDE, AND STARTER FERTILIZER COMBINATIONS ON PLANT SAFETY AND YIELD IN SUGARBEET

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Introduction:

Combining pesticide and fertilizer products into complex spray mixtures for a single implement pass through the field can be a valuable, input cost saving strategy for producers. Although this practice has become somewhat commonplace on many farms for both planting-time operations and after emergence of the crop, the impacts of such combinations on plant health or pest control efficacy should be thoroughly investigated before they are recommended for implementation on the farm.

Several insect pests, including wireworms, springtails, white grubs, and the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder) are annual threats to sugarbeet production in the Red River Valley (RRV) growing area. These root-feeding pests are often controlled 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 larval feeding pressure are expected, most producers also supplement the initial at-plant insecticide(s) with a postemergence granular or sprayable liquid insecticide application.

Fungicides are sometimes also used to manage soil-borne root diseases of sugarbeet such as Rhizoctonia damping off and Rhizoctonia crown and root rot, both of which are all 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. Starter fertilizer, applied at planting time, is also commonly used by RRV sugarbeet producers. However, little is known about the crop safety of combining these applications or if they either complement or impair pesticide performance. If demonstrated as safe for the crop and have a neutral or positive impact on pest control 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.

Two experiments, one focused on planting-time combinations and one on postemergence tank mixtures, were carried out to evaluate the impact of multicomponent application systems on sugarbeet seedling emergence, plant health, and resulting harvest yield and quality. Several treatment combinations, based on the following application groupings, were evaluated within these experiments:

1) Counter 20G insecticide, banded at planting (7.5 lb or 8.9 lb product/ac) with a concurrently applied (i.e., at same time through a separate delivery system) dribble-in-furrow application of 10-34-0 or 6-24-6 starter fertilizer, either with or without AZteroid (azoxystrobin) fungicide; and

2) Pilot 4E (chlorpyrifos) or Mustang Maxx (zeta-cypermethrin) insecticide applied as a postemergence band in a tank mixture with either Elatus (azoxystrobin and benzovindiflupyr), Excalia (inpyrfluxam), or Quadris (azoxystrobin) fungicide.

Materials and Methods:

This project involved two experiments (i.e., Study I and Study II) that were conducted during the 2025 growing season at the NDSU Prosper Experiment Farm near Prosper in rural Cass County, ND. Plots were planted on May 27, 2025, and Betaseed 8018 glyphosate-tolerant seed 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.

Planting-time applications. Planting-time applications of Counter 20G (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 (Study I) were delivered by using dribble in-furrow (DIF) placement. Dribble in-furrow treatments were applied in a 3:2 gallon ratio of three gallons 10-34-0 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. Pressurized CO_2-was used to propel spray output through the delivery system that was equipped with inline Teejet™ No. 24 orifice plates to achieve a finished output volume of five gallons per acre (GPA).

Postemergence insecticide applications. Additive postemergence insecticides applied in Study II included Pilot 4E and Mustang Maxx. Those applications, which included respective insecticide-only spray solutions, as well as either Pilot 4E or Mustang Maxx insecticide with either Elatus, Excalia, or Quadris fungicide, were made on June 24, which coincided with most plants being in the 4-leaf stage of development.

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. Postemergence granular insecticide output rates were regulated by using a SmartBox™ system mounted on a tractor-drawn four-row toolbar, and placement of insecticide in 4-inch bands was achieved by using Kinze™ row banders. Granules were incorporated into the soil by using two pairs of metal rotary tines that straddled each row. One pair of tines was positioned ahead of each bander, and a second pair was mounted behind it.

Plant Stand Counts: To determine treatment impacts on seedling emergence and survival throughout the growing season, surviving plant stands were counted in Study I on 26 June and 8 July, 2025 (i.e., 30 and 42 days after planting [DAP], respectively, and counts were carried out in Study II on 8 and 18 July (i.e., 42 and 52 DAP). Plant stand 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.

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. All plots in both experiments were harvested on September 16, 2025. 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 2025), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Results from both Study I and Study II are considered preliminary, as they are part of a multi-year project and both studies are anticipated to be repeated in at least one additional growing season. The results from two counts of surviving plant stands in Study I, presented in descending order of plant stands recorded at the final stand count (42 DAP), are shown in Table 1. At the first stand count (30 DAP), all treatments had favorable plant stands that hovered around 210 to 220 plants per 100 linear row feet; however, there were no significant differences between any of the treatments in this trial. The highest average stand counts (i.e., 231.7 plants/100 row ft) in Study I were observed in plots treated at planting time with Counter 20G at its moderate rate of 7.5 lb product per acre as a stand-alone treatment (i.e., no fungicide or starter fertilizer). Similarly, relatively high stands (i.e., 224.5 plants/100 row ft) were also observed in the stand-alone treatment of Counter 20G at its high labeled rate (8.9 lb/ac). The lowest stands recorded at 30 DAP in Study I, although not exceptionally low, occurred in the treatment comprised of Counter 20G insecticide at 7.5 lb/ac applied concurrently with a dribble in-furrow (DIF) tank mixture of 6-24-6 starter fertilizer and AZteroid fungicide.

Plant population patterns in the second stand count (42 DAP) were similar to those of the first count, including the finding of no statistically significant differences in surviving plant stands between any of the treatments. The highest plant stands recorded in the experiment occurred in the treatment comprised of Counter 20G at 8.9 lb/ac with a concurrent application of 6-24-6 starter fertilizer (without fungicide). Other treatments with relatively high surviving plant densities included the following: 1) Counter 20G insecticide applied at 8.9 lb/ac concurrently with a DIF-applied tank mixture of 6-24-6 starter fertilizer and AZteroid fungicide; 2) Counter 20G at its moderate rate of 7.5 lb product per acre as a stand-alone treatment (i.e., no fungicide or starter fertilizer); and 4) Counter 20G at 8.9 lb product per acre. The lowest average plant stands in Study I were observed in the treatment combination of Counter 20G insecticide at 7.5 lb/ac applied concurrently with a tank mixture of 6-24-6 starter fertilizer and AZteroid fungicide. The untreated check plots produced plant stand averages that remained roughly in the middle among all treatments, further supporting the indication that there were no significant pesticide or fertilizer impacts on sugarbeet plant stand establishment or survival in this experiment.

Table 1. *Plant stand counts* from an evaluation of azoxystrobin and starter fertilizers mixed with at-plant insecticides in the absence of insect pest pressure, Prosper, ND, 2025 (Study I)

Treatment/form.[a]	Placement[a]	Rate[b] (product/ ac)	Rate (lb a.i./ac)	Stand count[c] (plants / 100 ft)	
				30 DAP[c]	42 DAP[c]
Counter 20G 6-24-6	B DIF	8.9 lb 5 GPA	1.8 ---	219.5 a	228.3 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 ---	221.4 a	225.0 a
Counter 20G	B	7.5 lb	1.5	231.7 a	223.3 a
Counter 20G	B	8.9 lb	1.8	224.5 a	221.4 a
Counter 20G 10-34-0	B DIF	8.9 lb 5 GPA	1.8 ---	207.1 a	218.8 a
Counter 20G 6-24-6	B DIF	7.5 lb 5 GPA	1.5 ---	221.7 a	217.9 a
Untreated	---	---	---	217.6 a	216.7 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 ---	216.9 a	216.4 a
Counter 20G 10-34-0	B DIF	7.5 lb 5 GPA	1.5 ---	216.9 a	214.5 a
10-34-0	DIF	5 GPA	---	215.5 a	214.3 a
Counter 20G AZteroid FC+ 10-34-0	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	213.1 a	213.6 a
6-24-6	DIF	5 GPA	---	211.0 a	213.3 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 ---	206.9 a	205.2 a
LSD (0.05)				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]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; Post B = postemergence band (i.e., 4-inch width for granular products; 10-inch width for sprayable liquid formulations); DIF = dribble in-furrow

[c]Surviving plant stands were counted on June 26 and July 8, 2025 (i.e., 30 and 42 days after planting [DAP], respectively).

Yield data from Study I are presented in Table 2. The yield data from this experiment should be interpreted with the understanding it was planted later than a typical planting date for sugarbeet in the Red River Valley growing area. As such, yields of all treatments were accordingly lower than those a grower would usually achieve, but, the later planting date did not appear to affect treatment comparisons or the overall outcomes in this study. Another thing that is important to acknowledge, is that there were no statistically significant differences between any treatments in this experiment. However, some interesting and somewhat concerning patterns were evident with some of the combination treatments.

The highest recoverable sucrose yield in the experiment was observed in plots that received Counter 20G at 8.9 lb/ac and a concurrent application of 10-34-0 starter fertilizer. However, in a similar treatment that also involved Counter at 8.9 lb/ac, but where AZteroid was tank mixed with the 10-34-0 starter fertilizer, recoverable sucrose yield was reduced by 3.4%. Although that difference was relatively small, the inclusion of AZteroid resulted in a

gross revenue reduction of $100/acre. That disparity was not observed by adding AZteroid fungicide in a similar scenario when Counter was applied at the moderate (7.5 lb/ac) rate along with a concurrent application of 10-34-0 fertilizer. A similar pattern was also observed in plots treated with Counter 20G at its high rate and 6-24-6 starter fertilizer. In that scenario, recoverable sucrose was reduced by 7.8% when AZteroid was tank mixed with the 6-24-6 starter fertilizer. Although the difference was not statistically significant, the yield disparity that occurred from adding the fungicide was $162 per acre.

Table 2. *Yield parameters* from an evaluation of azoxystrobin and starter fertilizers mixed with at-plant insecticides in the absence of insect pest pressure, Prosper, ND, 2025 (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 10-34-0	B DIF	8.9 lb 5 GPA	1.8 ---	9,017.0 a	31.4 a	15.87 a	1004
Counter 20G 6-24-6	B DIF	8.9 lb 5 GPA	1.8 ---	8,994.9 a	31.9 a	15.69 a	961
10-34-0	DIF	5 GPA	---	8,972.1 a	32.0 a	15.56 a	947
6-24-6	DIF	5 GPA	---	8,789.5 a	32.2 a	15.21 a	859
Counter 20G AZteroid FC+ 10-34-0	B DIF DIF	8.9 lb 5.7 fl oz 5 GPA	1.8 0.15 ---	8,714.9 a	31.3 a	15.57 a	904
Counter 20G	B	7.5 lb	1.5	8,677.1 a	30.6 a	15.75 a	939
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 ---	8,672.5 a	30.5 a	15.73 a	940
Counter 20G 6-24-6	B DIF	7.5 lb 5 GPA	1.5 ---	8,662.3 a	30.9 a	15.58 a	911
Counter 20G 10-34-0	B DIF	7.5 lb 5 GPA	1.5 ---	8,579.2 a	31.1 a	15.32 a	867
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 ---	8,575.0 a	30.9 a	15.46 a	878
Counter 20G	B	8.9 lb	1.8	8,471.7 a	29.6 a	15.86 a	935
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 ---	8,297.4 a	30.6 a	15.11 a	799
Untreated	---	---	---	8,109.0 a	29.7 a	16.26 a	800
LSD (0.05)				NS	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]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; Post B = postemergence band (i.e., 4-inch width for granular products; 10-inch width for sprayable liquid formulations); DIF = dribble in-furrow

Data from counts of surviving plant stands for Study II are presented in Table 3. As mentioned in the Materials & Methods section of this report, all insecticide-treated entries in Study II were treated at planting with Counter 20G at its high rate of 8.9 lb of product per acre. It should also be noted that the treatments in Table 3 are listed in descending order of plant density at the second plant stand count.

Plant densities at the first stand count (42 days after planting [DAP]) ranged between about 227 and 234 plants per 100 row ft among treatments. The highest plant stands were recorded in plots that received the postemergence tank-mix combination of Pilot 4E insecticide at 2 pts per acre plus Elatus fungicide (7.1 fl oz/ac); however, there were no significant differences in surviving plant stands between this entry any of the other treatments in this experiment, including the untreated check. The untreated check plots had the lowest (numerically) average stand counts in the experiment, suggesting the possibility of a minor infestation of soil insect pests being present in the plot area. This is supported by the results of our pre-plant soil sampling for springtails (data not shown), which indicated the presence of a non-economic springtail infestation. The results of the second stand count date (52 DAP), were very similar to those from the first count in that there were no significant differences in surviving plant stands between any of the treatments, suggesting that neither the at-plant application of Counter 20G at its maximum labeled rate, nor any of the postemergence insecticides or insecticide/fungicide tank mixtures had any major impact on survivability of sugarbeet plants.

Table 3. *Plant stand counts* from an evaluation of postemergence-applied foliar insecticide-fungicide tank mixtures, Prosper, ND, 2025 (Study II)

Treatment/form.	Placement[a]	Rate (product/ ac)	Rate (lb a.i./ac)	Stand count[b] (plants / 100 ft)	
				42 DAP[c]	52 DAP[c]
Counter 20G Pilot 4E + Excalia	B 10-inch Post band	8.9 lb 2 pts 0.64 oz	1.8 1.0 0.01	234.3 a	249.6 a
Counter 20G Mustang Maxx + Quadris	B 10-inch Post band	8.9 lb 4 fl oz 10 fl oz	1.8 0.025 0.16	233.6 a	242.9 a
Counter 20G Pilot 4E	B 10-inch Post band	8.9 lb 2 pts	1.8 1.0	237.1 a	237.1 a
Counter 20G Mustang Maxx	B 10-inch Post band	8.9 lb 4 fl oz	1.8 0.025	229.6 a	234.6 a
Counter 20G Pilot 4E + Elatus	B 10-inch Post band	8.9 lb 2 pts 7.1 fl oz	1.8 1.0 0.2	228.9 a	232.9 a
Counter 20G Pilot 4E + Quadris	B 10-inch Post band	8.9 lb 2 pts 10 fl oz	1.8 1.0 0.16	223.9 a	232.9 a
Counter 20G Mustang Maxx + Excalia	B 10-inch Post band	8.9 lb 4 fl oz 0.64 oz	1.8 0.025 0.01	238.6 a	232.5 a
Counter 20G	B	8.9 lb	1.8	233.9 a	231.1 a
Counter 20G Mustang Maxx + Elatus	B 10-inch Post band	8.9 lb 4 fl oz 7.1 fl oz	1.8 0.025 0.2	224.6 a	228.6 a
Untreated	---	---	---	226.8 a	218.6 a
			LSD (0.05)	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; Post band = postemergence band.
[b]Surviving plant stands were counted on July 8 and July 18, 2025 (i.e., 42 and 52 days after planting [DAP], respectively).

Yield results from this experiment are presented in Table 4. As noted for Study I results, the yields recorded for all treatments in Study II were also somewhat lower than those a grower would typically achieve because Study II was also planted later than typical for sugarbeet production in the Red River Valley growing area. However, all treatments in the experiment were treated identically, so any observed relative differences among treatments should be reflective of what a grower could experience in a commercial production field.

The highest average recoverable sucrose yield in Study II was recorded in plots that received the single-component treatment of Counter 20G at 8.9 lb per acre, without an accompanying postemergence spray. Treatments in which significantly lower recoverable sucrose yields were recorded than that for the stand-alone Counter application included the following: 1) Counter 20G at planting followed by a postemergence tank mixture of Pilot 4E (2 pts/ac) plus Excalia (0.64 fl oz/ac); and 2) Counter 20G at planting followed by a postemergence tank mixture of Pilot 4E (2 pts/ac) plus Quadris (10 fl oz/ac). The lowest recoverable sucrose yield and root tonnage were recorded in plots that received the base treatment of Counter at planting and a postemergence tank mixture comprised of Pilot 4E plus Quadris. This combination produced significantly lower sucrose yield and root tonnage than any other treatment in the experiment, suggesting that it should not be used by producers in their postemergence insect and plant disease management practices. Other trends observed in the experiment suggest that, overall, Mustang Maxx appeared to be a slightly safer postemergence tank-mix partner than Pilot 4E with the three fungicides evaluated in this study. Another slight trend evident in these data was that Elatus fungicide appeared to be a safer fungicide tank mix partner with Mustang Maxx and Pilot 4E than Quadris, and that Excalia was intermediate in tank mixture safety between Elatus and Quadris.

The data from both Study I and II are considered preliminary because they involve results from just one year of information from a single location. As such, these experiments should be, and are expected to be repeated. The complete lack of statistically significant differences in stand counts and yield parameters among treatments in Study I at least suggests that there may not be major risks of consistent revenue losses resulting from the treatment combinations evaluated in that experiment.

Yield impacts from some of the treatments in Study II suggest at least caution when thinking about combining postemergence foliar applications of insecticide/fungicide tank mixtures, especially when either Pilot 4E insecticide or Quadris fungicide might be considered. Applying that combination at the rates used resulted in significant yield reductions and revenue losses that amounted to $147/ac when compared to the untreated check and $238/ac when compared to the Counter-only base planting-time treatment. It should be noted that both of these experiments were conducted in the absence of a measurable insect pest infestation. In addition to repeating this study under similar, no-pest environments, the net impacts of the treatment combinations tested should also be evaluated under economically significant insect pest (e.g., sugarbeet root maggot or springtail) pressure and possibly also root disease pressure to more fully understand the crop safety and pest management capability of these treatment combinations.

Table 4. *Yield parameters* from an evaluation of postemergence-applied foliar insecticide-fungicide tank mixtures, Prosper, ND, 2025 (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	B	8.9 lb	1.8	8815.9 a	30.9 ab	15.68 a	968
Counter 20G Mustang Maxx	B 10-inch Post band	8.9 lb 4 fl oz	1.8 0.025	8767.3 ab	31.7 a	15.37 a	890
Counter 20G Mustang Maxx + Elatus	B 10-inch Post band	8.9 lb 4 fl oz 7.1 fl oz	1.8 0.025 0.2	8673.7 ab	31.3 ab	15.39 a	887
Counter 20G Mustang Maxx + Excalia	B 10-inch Post band	8.9 lb 4 fl oz 0.64 oz	1.8 0.025 0.01	8587.8 ab	31.5 a	15.34 a	844
Counter 20G Pilot 4E	B 10-inch Post band	8.9 lb 2 pts	1.8 1.0	8548.9 ab	31.4 a	15.20 a	832
Untreated	---	---	---	8453.3 ab	30.3 ab	15.58 a	877
Counter 20G Mustang Maxx + Quadris	B 10-inch Post band	8.9 lb 4 fl oz 10 fl oz	1.8 0.025 0.16	8373.4 ab	29.9 ab	15.64 a	880
Counter 20G Pilot 4E + Elatus	B 10-inch Post band	8.9 lb 2 pts 7.1 fl oz	1.8 1.0 0.2	8354.9 ab	29.8 ab	15.61 a	876
Counter 20G Pilot 4E + Excalia	B 10-inch Post band	8.9 lb 2 pts 0.64 oz	1.8 1.0 0.01	8082.0 b	29.2 b	15.43 a	824
Counter 20G Pilot 4E + Quadris	B 10-inch Post band	8.9 lb 2 pts 10 fl oz	1.8 1.0 0.16	7010.9 c	25.1 c	15.50 a	730
			LSD (0.05)	724.22	2.16	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; Post band = postemergence band.

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ASSESSING EXPERIMENTAL INSECTICIDES FOR SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder) is a serious economic insect pest of sugarbeet in the Red River Valley (RRV) production area that borders North Dakota and Minnesota. For several decades, growers that produce sugarbeet in the United States have had a limited number of insecticide tools currently registered by the U.S. Environmental Protection Agency (EPA) for managing the SBRM. Another concern has been that, of the small number of insecticide options available for insect management in sugarbeet, the most widely used insecticides for controlling the SBRM and other insect pests during that time have belonged to the same insecticide action mode (i.e., acetylcholinesterase [ACHE] inhibition). In areas where economically damaging SBRM infestations develop on an annual basis, a common control approach involves two to three applications of ACHE-inhibiting insecticides within the same growing season to protect the crop from major economic loss. This long-term pattern of repeated use of ACHE inhibitors for root maggot control has exerted intense selection pressure for the development of insecticide resistance to these insecticides in RRV root maggot populations. Therefore, research is needed to develop alternative tools for SBRM management for preserving the long-term sustainability and profitability of sugarbeet production for growers affected by this pest. This experiment was carried out to screen several insecticide products that are either not EPA-registered at all, or are not currently registered for use in sugarbeet, for efficacy against sugarbeet root maggot in the RRV growing area.

Materials and Methods:

This experiment was conducted on a grower-owned field site near St. Thomas (Pembina County), ND during the 2025 growing season. Planting was done on May 7 with glyphosate-resistant seed (i.e., Betaseed 8018) by using a 6-row Monosem NG Plus 4 7x7 planter set to deposit seed at 1¼ inch depth and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. The outer "guard" rows (i.e., rows one and six on the planter) on each side of the plot served as untreated buffers. Each plot was 35 feet long, and 35-foot tilled alleys were maintained between replicates throughout the growing season. The experiment was arranged in a randomized complete block design with four replications of the treatments.

Planting-time insecticide applications. Counter 20G, applied at moderate and maximum labeled rates (i.e., 7.5 and 8.9 lb product/ac) was used for comparative purposes as a planting-time standard chemical insecticide in the experiment. Counter was applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular delivery rate was regulated by using a planter-mounted SmartBox™ electronic insecticide delivery system that was calibrated shortly before applications.

Experimental planting-time insecticides evaluated in the experiment included the following: 1) Abba Ultra (active ingredient: abamectin, a fermentation product of a soil-dwelling bacterium), 2) Aztec 4.67G (active ingredients: tebupirimifos [an organophosphate insecticide] and cyfluthrin [a pyrethroid insecticide]); 3) Delegate WG (active ingredients: spinetoram-J and spinetoram-L, nicotinic acetylcholine receptor modulators); 4) Ecozin Plus (active ingredient: azadirachtin, a botanical insecticide derived from neem tree extract); 5) Index (active ingredients: chlorethoxyfos [an organophosphate] and bifenthrin [a pyrethroid]); 6) Smart Choice 5G (active ingredients: chlorethoxyfos and bifenthrin [a pyrethroid insecticide]); and 7) Verimark (active ingredient: cyantraniliprole [a anthranilic diamide insecticide]). All planting-time liquid insecticides were applied by using dribble in-furrow (DIF) placement, which involved orienting microtubes (1/4" outside diam.) directly into the open seed furrow. Inline Teejet™ No. 20 orifice plates were used to provide backpressure for stabilizing the output rate of spray solutions from the microtubes. Insecticide/water solutions were delivered in a finished spray volume of 5 gallons per acre (GPA). Water was used as the carrier for all planting-time liquid insecticide applications, and it was adjusted to pH 6.0 before use.

Postemergence insecticide applications. Pilot 4E (active ingredient: chlorpyrifos, an organophosphate insecticide) was used as the postemergence broadcast SBRM management standard because similar chlorpyrifos-based products have been the most commonly used postemergence liquid insecticides for SBRM control by RRV sugarbeet growers for decades. Experimental postemergence insecticides evaluated in this trial included the following sprayable liquid products: 1) Abba Ultra (described above in at-plant treatments); and 2) Exirel (active ingredient: cyantraniliprole [a anthranilic diamide]. All postemergence sprays were applied on June 4 (i.e., about 3 days before peak SBRM fly activity) from 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™ XR 110015VS nozzles. All at-plant and postemergence insecticides were single, stand-alone applications. That is, there was no postemergence insecticide included in plots assigned to receive an at-plant insecticide treatment, and vice versa.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in this trial on August 5, 2025. Rating procedures involved randomly selecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and rating 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 according to sugarbeet quality and yield by harvesting all plots on October 2. 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 the soil using a mechanical harvester, and weighed in the field using a digital scale. A random subsample of 12-18 roots was collected from each plot and for subsequent sucrose content and quality analyses.

Data analysis: Data from root injury ratings and yield samples were subjected to analysis of variance (ANOVA) via the general linear models (GLM) procedure (SAS Institute 2025). Treatment means for all four response variables were separated by using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

As mentioned above, all insecticide entries in this trial were single-component control tools (i.e., none of the planting-time insecticide treatment plots received any postemergence insecticide protection, and none of the postemergence treatment plots had any planting-time protection). This practice is not recommended in high-risk areas such as St. Thomas, where severe SBRM infestations are common; however, these single-product applications were necessary to assess the efficacy of each product individually. The results from assessments of sugarbeet root maggot feeding injury in this experiment appear in Table 1. The average level of SBRM larval feeding injury recorded for the untreated check was 7.75 on the 0 to 9 scale of Campbell et al. (2000), which suggested that a high SBRM infestation was present for the experiment.

Table 1. *Larval feeding injury* in an evaluation of experimental at-plant and postemergence insecticides for sugarbeet root maggot control, St. Thomas, ND, 2025

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G	B	8.9 lb	1.8	4.52 h
Index	DIF	17.1 fl oz	0.37	4.80 gh
Counter 20G	B	7.5 lb	1.5	5.02 fgh
Verimark	DIF	10 fl oz	0.13	5.28 efg
Ecozin Plus	3 d Pre-peak Broadcast	56 fl oz	0.04	5.70 def
Delegate WG	DIF	6 fl oz	0.09	5.78 de
Exirel Insect Control	3 d Pre-peak Broadcast	20 fl oz	0.13	5.82 de
Smart Choice 5G	B	7.4	0.37	5.85 de
Pilot 4E	3 d Pre-peak Broadcast	2 pt	1.0	5.90 cde
Abba Ultra	DIF	10 fl oz	0.02	6.08 cd
Aztec Smartbox 4.67G	B	4.45	0.21	6.18 cd
Pilot 4E	3 d Pre-peak Broadcast	1 pt	0.5	6.55 bc
Abba Ultra	3 d Pre-peak Broadcast	10 fl oz	0.02	6.95 b
Untreated check	---	---	---	7.75 a
			LSD (0.05)	0.693

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; 3" TB = 3-inch band over open seed furrow at planting

All insecticide treatments provided significant (P < 0.05) reductions in SBRM feeding injury when compared to that recorded in the untreated check plots. The highest level of protection from root maggot feeding injury (i.e., lowest average root rating) was provided by Counter 20G applied at 8.9 lb product per acre. Two other insecticide treatments, Index, applied at 17.1 fl oz per acre and the lower (7.5 lb/ac) rate of and Counter 20G, provided similar levels of root protection from SBRM feeding injury that were not significantly different from that of the high rate of Counter.

The aforementioned top-performing treatments (i.e., Counter 20G at 7.5 and 8.9 lb, and the experimental product, Index) resulted in significantly greater SBRM control than both rates of Pilot 4E. In addition to Index, somewhat encouraging performance was also observed with Verimark, Ecozin Plus, and Delegate, as all three products resulted in significantly lower SBRM feeding injury than that recorded from plots treated with Pilot 4E at the lower, 1-pt rate. Although Abba Ultra was one of the lower-performing treatments in the experiment, applying it using DIF placement treatment resulted in root injury ratings that averaged nearly one entire point lower on the 0 to 9 scale, suggesting that placing the product into the seed furrow may be a more effective approach than a postemergence spray with that insecticide.

Yield data from this trial, shown below in Table 2, corresponded well with SBRM root-feeding injury rating results, and were even more encouraging. General performance patterns indicated that planting-time treatments resulted in greater yield benefits than postemergence-applied treatments. The experimental insecticide Index, applied at 17.1 fl oz per acre at planting time using DIF placement, resulted in the highest recoverable sucrose yield and root tonnage in the entire experiment. The economic results from the trial indicated that Index-protected plots generated a gross revenue increase of $484/ac when compared to the untreated check. Other planting-time treatments that resulted in comparatively high root and recoverable sucrose yields that were not statistically different from Index included Counter 20G (7.5 and 8.9 lb product/ac), Delegate WG, and Verimark. Gross revenue increases over the untreated check from Counter 20G were $476/ac and $383/ac for the 8.9-lb and 7.5-lb rates, respectively. Encouraging revenue increases were also observed with Delegate WG ($313/ac), Verimark ($296/ac), Exirel ($264/ac), and Ecozin Plus ($206/ac) when compared to the check.

Table 2. *Yield parameters* from an evaluation of experimental at-plant and postemergence insecticides for sugarbeet root maggot control, St. Thomas, ND, 2025

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Index	DIF	17.1 fl oz	0.37	9,572.4 a	30.1 a	16.92	1,298
Counter 20G	B	8.9 lb	1.8	9,374.9 ab	29.2 ab	17.00	1,290
Counter 20G	B	7.5 lb	1.5	8,521.3 abc	26.2 a-e	17.15	1,197
Delegate WG	DIF	6 fl oz	0.09	8,648.0 abc	26.9 abc	16.75	1,127
Verimark	DIF	10 fl oz	0.13	8,326.8 a-d	26.4 a-d	16.72	1,110
Ecozin Plus	3 d Pre-peak Broadcast	56 fl oz	0.04	8,195.4 bcd	27.0 abc	16.35	1,020
Exirel Insect Control	3 d Pre-peak Broadcast	20 fl oz	0.13	7,962.8 cde	25.0 c-f	16.82	1,078
Aztec Smartbox 4.67G	B	4.45	0.21	7,718.0 c-f	24.8 c-f	16.62	1,004
Smart Choice 5G	B	7.4	0.37	7,710.6 c-f	25.4 b-e	16.28	958
Pilot 4E	3 d Pre-peak Broadcast	2 pt	1.0	7,692.1 c-f	25.6 b-e	16.20	939
Pilot 4E	3 d Pre-peak Broadcast	1 pt	0.5	7,382.6 c-f	24.8 c-f	16.05	885
Abba Ultra	3 d Pre-peak Broadcast	10 fl oz	0.02	7,029.2 def	22.5 def	16.55	921
Abba Ultra	DIF	10 fl oz	0.02	6,805.5 ef	22.2 ef	16.25	862
Untreated check	---	---	---	6,470.2 f	21.2 f	16.38	814
			LSD (0.05)	1,349.1	3.98	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; 3" TB = 3-inch band over open seed furrow at planting

It is also worth noting that plots treated with a postemergence application of either Ecozin Plus or Exirel Insect Control produced numerically higher recoverable sucrose and root yields than either rate of Pilot 4E, the postemergence industry standard product in the experiment. Although those differences were not statistically significant, the gross revenue generated from a postemergence application of Exirel was $81/ac greater than that from a postemergence application of the high (2 pts/ac) rate of Pilot 4E. Similarly, the gross revenue generated from plots treated with a postemergence rescue application of Ecozin Plus was $139/ac higher than that produced by plots treated with Pilot 4E at the 2 pt/ac rate.

As mentioned above, it is important to understand that all insecticide treatments in this trial were single-applications (i.e., either at-plant or postemergence). Although this practice is not recommended in high-risk SBRM infestation areas, this approach was employed in the trial to isolate the performance level of each individual insecticide treatment. As such, all insecticide-treated plots were anticipated to sustain more SBRM feeding injury and incur greater yield loss than would typically occur in well-managed sugarbeet fields.

However, the results of this trial were very encouraging. Most notable was the performance of Index insecticide which provided the best protection from SBRM feeding injury, as well as, recoverable sucrose yield, and root tonnage in the experiment. The performance of Ecozin Plus, Delegate WG, Verimark, Exirel, and Ecozin Plus, were also encouraging. Further testing should be carried out on these and other experimental materials to identify viable alternatives to the currently used insecticides. The use of alternative insecticide active ingredients in place of the long-used ACHE inhibitors could assist with the prevention or delay of the development of resistance to those insecticides in SBRM populations. Products formulated with active ingredients belonging to these alternative modes of action could also provide viable tools for growers to sustainably and profitably produce sugarbeet in areas affected by this pest if the currently available conventional insecticides become unavailable in the future due to regulatory action or voluntary cancellations by manufacturers. The threat of losing any of these tools underscores the importance of this research and provides strong impetus for the identification of viable alternatives for SBRM management in the future. The findings presented here, while encouraging, are considered early-phase in nature. Next steps in this pursuit should include incorporating some of the better-performing experimental insecticide products into multi-component SBRM management systems that incorporate both at-plant and postemergence tools for effective, profitable, and environmentally compatible control of this major economic sugarbeet pest.

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ECONOMIC BENEFITS OF THE 2025 NDSU SUGARBEET PLANTER TEST STAND CLINICS

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Introduction:

Seed is one component among several others that contributes to the high input costs associated with sugarbeet production. As such, regular planter maintenance is a critical factor in optimizing plant establishment in the field. Uniformly spaced seed improves plant development and harvestability. NDSU research has demonstrated that optimal seed spacing and resultant plant stand establishment are key determinants of fields producing high root and recoverable sucrose yields. Correspondingly, proper seed spacing can contribute to more effective harvesting operations that minimize mechanical injury to roots, thus improving their long-term storability after harvest.

The NDSU Sugarbeet Planter Test Stand Clinics are a service activity that is organized and carried out by university personnel in cooperation with agriculturists from American Crystal Sugar Company, the Minn-Dak Farmers Cooperative, and the Southern Minnesota Beet Sugar Cooperative. Most of the funding for the program is provided by the Sugarbeet Research and Education Board of Minnesota and North Dakota (SBREB). Dr. Joe Giles (NDSU professor, ret.) began the test stand clinics in 1984 with Mr. Norman Cattanach (NDSU Research Specialist, ret.). Historically, they have been held between February and early April at multiple locations throughout the Red River Valley, eastern Montana, and southern Minnesota. This program has been an important component of pre-season field preparations for hundreds of sugarbeet farmers throughout these production areas for over four decades, and it continues to serve sugarbeet producers in Minnesota and North Dakota.

This program is designed to assist sugarbeet producers with regular maintenance, troubleshooting, and adjustments on sugarbeet planter row units to optimize seed delivery during planting operations. The overall goal is to set the stage for maximum profitability in each of their sugarbeet fields by delivering proper, consistent delivery rates of undamaged seed per unit row length according to research-based recommendations.

Materials and Methods:

Activities involved with preparation for the Test Stand Clinics include cleaning, testing, troubleshooting and repair of each of the six mechanical test stand units. Regular maintenance tasks often involve screen and filter cleaning, pump replacements, and oil changes. Concurrent to those activities is the task of scheduling the clinics throughout the three sugarbeet cooperative growing areas and requesting/arranging for assistance from agriculturists and other allied agriculture personnel from agricultural industry for each clinic location. Other important activities include transport and operation, as well as maintenance of the stand units between and even during some of the clinics when units break down and require service or repair.

At each clinic, the accuracy of seed delivery is evaluated on planter row units brought in by participating growers. Units that deliver erratically spaced seed are then dismantled and evaluated for broken or worn out components. On-site specialists then provide advice on parts needed or assistance with repairing them that day. Additionally, growers can compare delivery of various seed sizes and coating levels through their row units, try different seed plates, evaluate vacuum settings, and get helpful information from planter experts, seed company representatives, sugar cooperative agronomists, university personnel, and other producers.

Results and Discussion:

The cost of testing row units at implement dealerships and equipment service centers was estimated at about $25 in 2015 (Cattanach and Chatterjee 2016). An inflation calculator (Webster 2026) was used to determine that the current cost of that service in 2025 would be about $33.86 per unit. During the 2025 Test Stand Clinic season, a total of 13 clinics were held over 23 testing days (i.e., excluding travel/transport days) throughout the North Dakota and Minnesota sugarbeet-growing areas between February and April of 2025. In that period, 269 growers participated, and a total of 6,644 individual row units were tested.

Given the cost savings of this free service (estimated at a value of $33.86/unit) that was provided by the SBREB and NDSU, the clinics were estimated to have saved participating producers a collective $224,966. Based on information provided by the participating producers, the units tested and were subsequently used to plant a total of 159,398 sugarbeet production acres within the three North Dakota and Minnesota sugarbeet cooperatives. In a recent analysis of anonymous grower data obtained from two of those cooperatives, it was estimated that growers who regularly participate in the Test Stand Clinics or those that regularly have their units tested elsewhere generate an average of 2.31 to 3.0% higher yields and resulting revenues than those who do not regularly have their planters tested. By using the more conservative value of a 2.31% yield increase and extrapolating that benefit to the row units tested and acres impacted, we estimate the gross direct economic benefit of the 2025 Planter Test Stand Clinics program to the region at $8,219,342, which does not include the benefit of cost savings to individual growers for testing the units. The yield and revenue benefits that occur by using properly functioning planter row units are likely associated with uniform plant stands per unit row length, even seedling emergence, and lower frequencies of seed skips or double-planted seeds, thus leading to healthy plant development, improved harvestability, and better postharvest root storability. These figures, which were calculated conservatively, easily justify the costs and efforts associated with running the clinics.

Table 1. Sugarbeet Planter Test Stand Clinic locations and impacts, 2025

Location	Host	Test days	Grower participants	Units tested	Grower cost savings ($33.86/row unit)[a]
Renville	Southern MN Beet Sugar Coop.	2	11	216	$7,314
Wahpeton	Minn-Dak Farmers Coop.	3	38	830	$28,104
Kennedy	Kevin Klein shop	1	21	528	$17,878
Grafton	Pro-Ag Equipment	1	11	252	$8,533
East Grand Forks, MN	Steve Adams Shop	2	16	348	$11,783
Ada	Valley United Cooperative	2	21	540	$18,284
Crookston	Valley Plains Equipment	2	24	564	$19,097
Hillsboro	Valley Plains Equipment	2	13	324	$10,971
Euclid/Angus	Strickler farm shop	2	23	624	$21,129
Cavalier	Cavalier Equipment	1	31	816	$27,630
Moorhead	American Crystal seed plant	2	27	798	$27,020
Comstock	Askegaard shop/Betaseed	2	28	672	$22,754
St. Thomas	Sagert shop/Betaseed	1	5	132	$4,470
	TOTALS	**23**	**269**	**6,644**	**$224,966**

[a]Estimated cost of service per planter row unit in 2025 by using the inflation calculator of Webster (2026) to convert cost of $25 in 2015 as cited by Cattanach and Chatterjee (2016)

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PLANT PATHOLOGY

SURVEY OF FUNGICIDE USE AND DISEASE MANAGEMENT IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2025

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The eleventh annual fungicide practices and disease management live polling survey was conducted using Point Solutions (Turning Point Technology) during the Sugarbeet Growers' Seminars held during February of 2026. The survey primarily focused on the responses from the growers attending the Fargo, Grand Forks, Wahpeton, ND and Willmar, MN seminars based on production practices from the 2025 growing season. Respondents at each seminar indicated the county in which the majority of their sugarbeets were produced (Table 1-4). The average sugarbeet acreage per respondent grown in 2025 was calculated to be 793 acres (Table 5). Agronomic practices such as crop rotation and tillage system were also assessed. Respondents indicated that wheat and field corn were the most frequent crops preceding sugarbeet in rotation (47% and 38%, respectively, Table 6). Growers at Fargo and Grand Forks were asked about cover crops, 31% of those surveyed used barley as cover crop, and 17% planted winter rye (Table 7). Most growers region-wide (97%) followed conventional tillage rather than strip tillage or no-till methods (Table 8).

Based on the survey done on the four seminar locations, 60% of total responses indicated that plant diseases were the most serious production problem. Multiple responses were accepted for this question. In particular, 55% indicated Cercospora Leaf Spot (CLS) was the most serious disease problem. 2%, 3% and 1% of the growers indicated Aphanomyces, Rhizoctonia and Rhizomania was the most serious production problem. The remaining 40% of the survey responses reported that weeds, poor emergence/stand, or insects were the major production challenges following diseases (Table 9).

When growers were asked about soil-borne diseases, 60% of the responses indicated Rhizoctonia as the main soil-borne disease problem. 15% indicated Aphanomyces as the biggest issue, 5% reported problem of Fusarium and 5% showed Rhizomania as a plant disease affecting the production. However, 15% of the responses did not report any issues caused by soil-borne diseases (Table 10).

Use of tolerant sugarbeet varieties and preventative fungicides are two popular and effective methods of managing Rhizoctonia diseases. Overall, 72% of the growers used a specialty variety for Rhizoctonia in 2025, with attendees of the Willmar and Wahpeton seminars being more likely to use specialty Rhizoctonia varieties (Table 11). Use of seed treatments, in-furrow, and post-emergent fungicides to control Rhizoctonia was assessed among the sugarbeet growers at each location. 40% of the participants responded that they use seed treatments alone as a way to manage Rhizoctonia. 20% used a seed treatment plus in-furrow application, and 24% used a post-emergent application with seed treatments. 15% of the participants used seed treatments, in-furrow and post emergent application and only 1% of the surveyed growers added a second post-emergent application (Table 12). Among the post-emergent fungicides used by the growers to control Rhizoctonia, the most frequently utilized product was Excalia followed by Quadris, Azteroid, Proline and then Azterknot (Table 13). Notably, this was the first year that Excalia was most used by sugarbeet growers. However, 33% of growers used one of several azoxystrobin-based products (Quadris, Azteroid, or Azterknot, Table 13). Of the 53% of respondents who used post-emergent fungicides, 11% made a banded application and 42% made a broadcast application (Table 14).

75% of the participants did not apply precipitated calcium carbonate i.e., waste lime in 2025 growing season while, 11% applied less than 5 tons per acre and 14% applied between 5 and 10 tons per acre to control Aphanomyces (Table 15).

Proactive and preventative fungicide applications continue to be the major management strategy for CLS. Questions related to the use of fungicide for CLS were asked to the growers across all the four seminar locations. 30% of growers surveyed made 6 fungicide applications to control CLS. 26% and 20% of growers surveyed made 5 and 7 applications, respectively (Table 16). Due to high prevalence of CLS in 2025, 14% of growers surveyed at the Willmar seminar made 8 or more

applications for CLS (Table 16). 60% of the growers made their first application of fungicide for CLS control between June 25-July 1 while, 19% and 20% of the growers started before June 25 and between July 2- 10 respectively (Table 17). For the last CLS fungicide application, 40% of those surveyed made the final CLS application between September 1-10, and 38% made a final CLS application between 11-20 (Table 18).

Spray practices were addressed with two questions. First, 34% of the growers responded that they did not have any CLS fungicides application made by aerial applicator, while 30% reported that up to20% of their total fungicide application were made by an aerial applicator (Table 19). Next, 16% of the growers in the survey reported using 11-15 gallons of water per acre to apply CLS fungicides, 18% reported 16-19 gallons per acre and more than half (60%) of growers at the seminars used 20 gallons of water per acre (Table 20).

Table 1. 2026 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2025

County	Percent of responses	Number of responses
Barnes	5%	1
Becker	9%	2
Cass	9%	2
Clay	41%	9
Norman/Mahnomen	27%	6
Ransom	0%	0
Richland	0%	0
Steele	0%	0
Traill	9%	2
Wilkin/Otter Tail	0%	0
Total	100%	22

Table 2. 2026 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2025

Location	Percent of responses	Number of responses
Grand Forks	17%	6
Mahnomen	0%	0
Marshall	3%	1
Nelson	0%	0
Pennington/Red Lake	3%	1
Polk	57%	20
Steele	0%	0
Traill	6%	2
Walsh	11%	4
Other	3%	1
Total	100%	35

Table 3. 2026 Wahpeton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2025

County	Percent of responses	Number of responses
Cass	4%	2
Clay	15%	8
Grant	13%	7
Otter Tail	0%	0
Ransom	0%	0
Richland	20%	11
Roberts	2%	1
Stevens	2%	1
Traverse	4%	2
Wilkin	41%	22
Total	100%	54

Table 4. 2026 Willmar Grower Seminar – Number of survey respondents by county growing sugarbeet in 2025

County	Percent of responses	Number of responses
Chippewa	38%	30
Kandiyohi	8%	6
Pope	1%	1
Redwood	3%	2
Renville	29%	23
Yellow Medicine	1%	1
Stevens	5%	4
Swift	10%	8
Other	5%	4
Total	100%	79

Table 5. Total sugarbeet acreage operated by respondents in 2025.

Location	Responses	Acres of sugarbeet									
		<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		----------% of responses----------									
Fargo	20	0	5	0	5	20	25	10	20	10	5
Grand Forks	34	0	9	6	3	21	24	6	18	12	3
Wahpeton	51	4	8	6	8	25	16	14	16	4	0
Willmar	74	5	4	8	15	19	12	8	16	5	7
Total	179	3	6	6	9	21	17	9	17	7	4

Table 6. Crop (grown in 2024) preceding sugarbeet (grown in 2025).

Location	Responses	Previous crop					
		Corn (field)	Corn (sweet)	Dry Beans	Peas	Soybean	Wheat
		----------% of responses----------					
Fargo	20	0	0	0	0	15	85
Grand Forks	35	0	0	0	0	0	100
Wahpeton	52	21	0	0	0	17	62
Willmar	72	81	11	0	0	8	0
Total	179	38	5	0	0	10	47

Table 7. Fall or Spring seeded cover crop used by sugarbeet growers in 2025.

Location	Responses	Barley	Oat	Winter Rye	Spring Wheat	Winter Wheat	Other	None
		----------% of responses----------						
Fargo	18	22	0	6	0	0	0	72
Grand Forks	36	36	8	22	14	0	3	17
Total	54	31	6	17	9	0	2	35

Table 8. Primary method of tillage used by sugarbeet growers in 2025.

Location	Responses	Conventional Tillage	No-Till	Strip Tillage
		----------% of responses----------		
Fargo	21	95	0	5
Grand Forks	35	94	6	0
Wahpeton	52	96	0	4
Willmar	74	99	0	1
Total	182	97	1	2

Table 9. Sugarbeet growers' most serious production problem in 2025.

Location	Responses	Aph[1]	CLS[2]	Emergence/ Stand	Herbicide Injury	Rhizoctonia	Rhizomania	Weeds	Root maggot
				----------% of response----------					
Fargo	27	0	59	15	0	0	0	22	4
Grand Forks	64	2	34	34	0	2	0	28	0
Wahpeton	55	2	76	5	2	4	0	11	0
Willmar	83	2	55	6	0	4	1	31	0
Total	229	2	55	15	1	3	1	22	1

[1]Aphanomyces
[2]Cercospora Leaf Spot

Table 10. Soilborne diseases affecting sugarbeet production in 2025.

Location	Response	Rhizoctonia	Aphanomyces	Fusarium	Rhizomania	None
		----------% of responses----------				
Fargo	25	52	12	16	4	16
Grand Forks	49	53	22	2	8	14
Wahpeton	55	65	12	6	2	16
Willmar	82	65	15	2	4	15
Total	211	60	15	5	5	15

Table 11. Use of specialty varieties to control Rhizoctonia diseases in sugarbeet in 2025.

Location	Responses	Yes	No
		----------% of responses----------	
Fargo	20	70	30
Grand Forks	36	50	50
Wahpeton	50	74	26
Willmar	70	83	17
Total	176	72	28

Table 12. Methods used to control Rhizoctonia diseases in sugarbeet in 2025.

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	20	40	25	15	15	5
Grand Forks	37	27	35	30	8	0
Wahpeton	50	76	12	8	4	0
Willmar	70	21	16	34	27	1
Total	177	40	20	24	15	1

Table 13. Post-emergent fungicides used to control Rhizoctonia diseases in 2025.

Location	Responses	Azteroid	Azterknot	Excalia	Quadris or generic	Proline	Elatus	Other	None
		----------% of responses----------							
Fargo	20	5	0	45	20	5	0	0	25
Grand Forks	40	35	2	8	22	8	0	0	25
Wahpeton	51	4	0	2	10	4	0	2	78
Willmar	70	10	3	39	20	3	0	3	23
Total	181	13	2	22	18	4	0	1	40

Table 14. Application methods of post-emergent fungicides used to control Rhizoctonia diseases in 2025.

Location	Responses	Band	Broadcast	None Applied
		----------% of responses----------		
Fargo	20	25	50	25
Grand Forks	39	8	51	41
Wahpeton	51	4	14	82
Willmar	70	14	56	30
Total	180	11	42	47

Table 15. Application rates of precipitated calcium carbonate (waste lime) applied in 2025

Location	Responses	None	<5 Tons/Acre	5-10 Tons/Acre
		----------% of responses----------		
Fargo	20	70	0	30
Grand Forks	39	90	0	10
Wahpeton	51	69	6	25
Willmar	70	73	23	4
Total	180	75	11	14

Table 16. Total number of fungicide applications made to control Cercospora Leaf Spot in 2025

Location	Responses	0	1	2	3	4	5	6	7	8	>8
		----------% of responses----------									
Fargo	20	0	5	0	0	25	40	20	10	0	0
Grand Forks	40	0	0	0	18	32	30	20	0	0	0
Wahpeton	51	0	0	0	2	6	35	45	10	0	2
Willmar	72	0	0	1	1	3	12	28	40	8	6
Total	183	0	1	1	5	12	26	30	20	3	2

Table 17. First application date of fungicides to control Cercospora Leaf Spot in 2025.

Location	Responses	Before June 25	June 25-July 1	July 2-10	After July 10
		----------% of responses----------			
Fargo	21	0	81	14	5
Grand Forks	42	7	48	45	0
Wahpeton	50	6	76	16	2
Willmar	69	42	49	9	0
Total	182	19	60	20	1

Table 18. Last application date of fungicides to control Cercospora Leaf Spot in 2025

Location	Responses	Before Aug 21	Aug 21-31	Sept 1-10	Sept 11-20	After Sept 20
		----------% of responses----------				
Fargo	21	5	0	43	43	10
Grand Forks	42	0	10	50	33	7
Wahpeton	49	2	22	35	35	6
Willmar	70	0	17	37	41	4
Total	182	1	15	40	38	6

Table 19. Percentage of total fungicide applications for CLS made by an aerial applicator in 2025.

Location	Responses	0%	1%-20%	21%-40%	41%-60%	61%-80%	81%-99%	100%
		----------% of responses----------						
Fargo	21	29	38	5	10	5	0	14
Grand Forks	42	45	29	12	2	0	2	10
Wahpeton	52	38	35	17	6	4	0	0
Willmar	68	25	25	25	15	4	1	4
Total	183	34	30	18	9	3	1	5

Table 20. Gallons of water per acre used to apply CLS fungicides (ground application) in 2025.

Location	Responses	11-15	16-19	20	20+
		----------% of responses----------			
Fargo	21	48	24	24	5
Grand Forks	39	33	28	31	8
Wahpeton	52	13	15	69	2
Willmar	71	0	13	79	8
Total	183	16	18	60	6

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

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INTRODUCTION

Cercospora leaf Spot (CLS) caused by fungal pathogen, *Cercospora beticola*, is the most economically significant foliar disease of sugarbeet in Minnesota and North Dakota. This disease limits sugar production by reducing both yield and sucrose concentration at harvest. Integrated approaches focusing on the use of tolerant varieties, cultural practices such as crop rotation, residue management, deep tillage, with timely application of effective fungicides can play a crucial role in limiting CLS severity and ultimately sugar and yield loss.

Fungicide applications have long been one of the most effective and significant tools in managing CLS (Khan and Smith 2005). The growers of ND and MN mostly rely on demethylation inhibitors (DMIs; FRAC 3), triphenyltin hydroxide (tin/TPTH; FRAC 30) and quinone outside inhibitors (strobilurins/QoIs; FRAC 11) to control CLS. Frequent use of fungicides with same mode of action coupled with the polycyclic life cycle and prolific sporulation of *C. beticola* are risk factors in developing fungicide resistance (van den Bosch 2014), increasing selection pressure and opportunity for mutation (Bolton et al. 2012). In populations of *C. beticola*, reduced fungicide sensitivity has been detected in several key active ingredients used for growing seasons. These include tin, thiophanate methyl or methyl benzimidazole carbamate (MBC; FRAC 1), multiple DMIs and QoIs (Secor et al. 2023). Although DMI and QoI resistant isolates may show reduced ability to infect sugarbeet in compared to sensitive isolates in absence of fungicides, this reduction is minimal but enough for fungicide-resistant isolates to persist over-time (Liu et al. 2023). Therefore, practices have shifted from individual treatments to to tank mixing fungicides and mode of action rotation in programs (Khan and Nelson 2005) limiting the growth of fungicide-resistant isolates of *C. beticola.* Evaluation and selection of fungicides, initial spray timing, and application sequences has been a priority of growers and cooperatives of ND and MN to control CLS.

This project focuses on assessing the performance of spray programs with early first applications, relationship between different fungicide programs, latent *C. beticola* infections, presence of fungicide-resistant isolates, and yield parameters and quality at harvest.

Objectives of the project:

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

METHODS and MATERIALS

Field Trials

The experiment was conducted at two locations near Foxhome, MN and near Kragnes, MN. At each location, two similar trials were conducted, one planted with a CR+ variety, Beta 7231 that had a 2-year-average 2.0 CLS rating and a non-CR+ variety, Crystal 912 that had a 2-year average 5.0 CLS rating (Brantner and Moomjian 2023). Standard seed treatments were used. Planting dates were April 25th at Foxhome, and May 9th at Kragnes. Each plot consisted of six 30-foot-long rows with 22-inch spaces in randomized complete block design with four replications. The data of CLS severity rating was collected throughout the season. The scale developed by Jones and Windels (1991) was used to rate disease severity in the center two rows of each plot. Area under disease progress curve (AUDPC) was calculated from CLS severity and used to compare disease severity between plots across both locations.

Plots were inoculated with *C. beticola* infested leaf material from 2024 season, mixed with talc in 3:2 ratio, at a rate of 5.0 lbs per acre. Inoculations were performed at Foxhome on July 9th and Kragnes on July 10th. Only the four center rows (2-5) were treated using a tractor-mounted CO2-pressurized boom sprayer calibrated to 17 gallons per acre at 60 psi. The treatments varied by date of the first fungicide application date and interval between subsequent applications (Table 1). Fungicide sequence and materials used is indicated in Table 2. Yield and recoverable sugar were assessed at harvest on September 22nd at Foxhome and on September 24th at Kragnes. At harvest, plots were first mechanically defoliated and then the center two rows were harvested. Randomly selected roots, weighting approximately 25, were sent to the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN and analyzed for sugar quality. The effect of treatments on yield, recoverable sugar, and area under the disease progress curve (AUDPC) was evaluated in R version 4.5.0.

Table 1. Treatment list and application schedule description of treatments for the sugarbeet field trials conducted near Kragnes, MN, and Foxhome, MN in 2025. One CR+ and one CLS-susceptible variety were used at each location.

Treatment	Time of first Application	Application Interval	Number of Applications	Application Dates
1	Mid-June	10-14 days	6	A B C D E F
2	Late June	10-14 days	5	B C D E F
3	Late June	Based on DIV*	4	B D E F
4	Late June	10-14 days then 21-28 days	4	B C E F†
5	Early July	10-14 days	4	C D E F
6	Early July	10-14 days then based on DIV	4	C D E F
7	Early July	10-14 days then 21-28 days	4	C D F
8	Disease Onset	10-14 days the based on DIV	3	D E F
9	3-5% CLS Severity	10-14 days	3	D E F
10	Non-treated Check	NA	0	NA

*DIV= Daily Infection Value
**Application dates at Foxhome: A = June 19th, B = July 1st, C = July 14th, D = July 30th, E = August 15th, F = August 25th,. Application dates at Kragnes: A = June 19th, B = July 2nd, C = July 17th, D = July 31st, E = August 12th, F = August 27th.
† Treatment 3 had a shorter final spray interval than originally intended.

Table 2. The same fungicide modes of action and tank mix partners were used for all treatments each trial conducted in 2025. Treatments with later fungicide program start dates did not use all six applications.

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

Molecular assays for CLS detection and fungicide resistance profiling

Sugarbeet leaf samples were collected from each of the center two rows prior to each fungicide application throughout the growing season. Each sample consisted of three leaves taken at approximately 5-foot intervals from within the rows. 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

The cumulative rainfall during the growing season was 33.7 and 18.7 inches from the date of planting to date of harvest at the Foxhome and Kragnes locations, respectively. At the Foxhome site, the average CLS rating in the nontreated control plots was 7.8 at harvest, while the equivalent plots at the Kragnes site had a rating of 5.4. This variation in CLS disease pressure was likely influenced mainly by environmental factors. At both locations, the average daily temperature high was 67°F from June 1st through harvest. Rainfall had a greater influence on disease risk. There were relatively high DIVs recorded in 2025 by the North Dakota Agricultural Weather Network (NDAWN) at Foxhome compared to Kragnes (Glyndon weather station). NDAWN recorded cumulative DIVs of 188 at Foxhome and 159 near the Kragnes site. As a result, there was no difference between the fungicide application schedules of treatments 4 and 5, and between treatments 8 and 9 when DIV was considered in these particular trials. Due to the need to avoid wet conditions and waterlogged soil, late June applications were actually made during the first few days in July. This delay reflects grower practices in the region.

At the Kragnes location, for both CR+ and non-CR+ varieties, the fungicide program that began in mid-June and late June, six applications or five applications respectively, with subsequent applications made at approximately 14 days intervals ("standard intervals") had significantly lower CLS disease severity compared to non-treated control plots (Table 3). Similarly, at Foxhome location, regardless of sugarbeet varietal tolerance to CLS, fungicide programs that began in mid-June with standard application intervals had the lowest AUDPC value, indicating reduced CLS severity. For CR+ sugarbeet, fungicide programs initiated either in late June, early July, 3-5% severity or disease onset was reported having statistically similar level of CLS control ($P = 0.002$). However, on non-CR+ sugarbeet, spray programs that began in late June or early July (with standard interval or extended interval) significantly improved disease control compared to programs starting at 3-5% severity or disease onset. These treatments only had three fungicide applications during the season, and had significantly increased CLS severity ($P = 0.03$), similar to non-treated control plots.

As observed in these experiments, for both CR+ and non-CR+ varieties, early fungicide applications were associated with increased recoverable sugar per acre (RSA), but not always at a statistically significant level. In Kragnes location, the spray program initiated on early July and late June had higher RSA for non-CR+ variety ($P = 0.001$) and CR+ variety ($P = 0.05$) respectively. Similarly, at the Foxhome location, late June and mid-June program start dates resulted in significantly higher recoverable sugar for non-CR+ ($P = 0.04$) and CR+ ($P = 0.001$) varieties, in comparison to later programs start dates. Decreased RSA was reported in non-treated control as well as in the spray program that began at disease onset in both the locations, despite differences in CLS pressure.

Complete analysis of fungicide resistance profiles from the 2025 season is underway and will be prepared for publication and distribution in the *Journal of Sugar Beet Research* or comparable academic journal in combination with results from the 2024 season.

Table 3. Effect of fungicide program start date and interval on Cercospora leaf spot disease severity (area under the disease progress curve), yield, and recoverable sugar per acre (RSA) in CR+ and non-CR+ sugarbeet at field trial near Foxhome, MN and Kragnes, MN in 2025.

Location/ Variety	Program start date/ Intervals[1]	CLS Severity (AUDPC)[2]	Yield (tons/A)	RSA[3] (1000 lbs)
Foxhome/ CR+	Mid-June/ Standard	71.2 a	34.5 a	14.2 a
	Late June/ Standard	83.3 ab	31.7 a	13.9 ab
	Late June/ DIV	82 ab	33.1 a	14 ab
	Late June/Extended	74.6 a	27.2 ab	13.7 abc
	Early July/ Standard	93.8 ab	30.4 ab	13.8 ab
	Early July/ DIV	96.3 ab	27 ab	13.6 abcd
	Early July/ Extended	100.9 abc	26.9 ab	13.4 bcd
	Disease Onset/ DIV	141.5 cd	26.2 ab	12.9 de
	3-5% CLS Severity/ Standard	123.1 bc	26.5 ab	13.1 cde
	Non-treated Check	176.1 d	20.3 b	12.4 e
	P =	0.002	0.001	NS[4]
Foxhome/ non-CR+	Mid-June/ Standard	90.6 a	40.2 a	12.5 a
	Late June/ Standard	109.5 ab	33.4 abc	12 ab
	Late June/ DIV	106.2 ab	32.1 abc	12.6 a
	Late June/Extended	108.7 ab	37.5 ab	12.1 ab
	Early July/ Standard	147.2 bc	29.9 bc	11.4 bc
	Early July/ DIV	146.8 bc	32.8 abc	11.3 bc
	Early July/ Extended	164.9 c	25.9 c	10.7 cd
	Disease Onset/ DIV	224.6 d	28.5 bc	10.6 cd
	3-5% CLS Severity/ Standard	224.1 d	27.4 c	10 d
	Non-treated Check	255.6 d	28.7 bc	9.7 d
	P =	0.03	0.04	0.04
Kragnes/ CR+	Mid-June/ Standard	11.4 a	35.1 ab	14.9 ab
	Late June/ Standard	13.2 ab	37.3 a	15.6 a
	Late June/ DIV	16.9 ab	33.1 ab	15.2 ab
	Late June/Extended	13.8 ab	33.2 ab	15 ab
	Early July/ Standard	23.6 bcde	34 ab	14.8 ab
	Early July/ DIV	25.2 cde	32.1 ab	15.1 ab
	Early July/ Extended	21.2 abc	34.2 ab	14.7 ab
	Disease Onset/ DIV	30.9 de	33 ab	14.7 ab
	3-5% CLS Severity/ Standard	35.1 d	29.3 ab	15.4 a
	Non-treated Check	68.1 e	26.2 b	14.2 b
	P=	<0.001	0.05	NS
Kragnes/ non-CR+	Mid-June/ Standard	41.1 a	37.3 ab	12.9 ab
	Late June/ Standard	51 ab	37.7 ab	12.1 ab
	Late June/ DIV	66.9 abcd	39.8 a	13.1 a
	Late June/Extended	59.1 abc	38.2 ab	13 a
	Early July/ Standard	89.9 cdef	33.5 ab	12.6 ab
	Early July/ DIV	85.8 bcde	35.2 ab	13 a
	Early July/ Extended	65.6 abcd	38.4 ab	13.1 a
	Disease Onset/ DIV	101 def	32.4 ab	11.9 ab
	3-5% CLS Severity/ Standard	110 ef	36.1 ab	11.5 bc
	Non-treated Check	126.8 f	28.6 b	10.4 c
	P =	< 0.01	0.001	0.05

[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 Curve
[3]Recoverable Sugar per Acre
[4]Non-significant

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OPTIMIZING CERCOSPORA LEAF SPOT MANAGEMENT IN DIFFERENT REGIONS OF NORTH DAKOTA AND MINNESOTA

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INTRODUCTION

Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola*, remains the most devastating foliar disease of sugarbeet in Minnesota and North Dakota despite the regular and widespread use of chemical controls and tolerant varieties. Although asymptomatic CLS infections are often detected prior to sugarbeet row closure (Wyatt 2025), the combination of row closure, moisture as rainfall or humidity, and temperature create prime conditions for symptom development and disease epidemics from July through September. Given the 300-mile north-south spread of sugarbeet grown in MN and ND, environmental conditions vary considerably. During the 2024 season, 74% of sugarbeet growers in the southern Red River Valley (RRV) and in southern Minnesota applied four or more fungicide applications to CR+ sugarbeet (Branch et al. 2025). In contrast, only 32% of growers in the northern RRV applied four or more fungicide applications to control CLR. When the northernmost growers are considered alone, only 3% applied 4 or more fungicide application in 2024 (Branch et al. 2025). Clearly, the need for chemical control varies on a north-south axis.

The purpose of this project was to evaluate several fungicide programs, differing in application frequency and timing, across multiple locations ranging from south-central Minnesota to northeastern North Dakota. Both CR+ and non-CR+ sugarbeet varieties were used, despite no difference in best management practices or cooperative recommendations for CLS control between the categories. A second year of this experiment is planned for the 2026 season, and results in this report may be considered preliminary.

Project objectives:

- Evaluate the relative performance of CLS fungicide programs applied to CR+ and non-CR+ varieties at multiple locations, targeting unique environments in the sugarbeet-growing regions of ND and MN.
- Evaluate the effect of each treatment on sugarbeet yield and sucrose content within each location to fine-tune recommendations.

METHODS AND MATERIALS

Field Trials

Locations in 2025 for this project were Renville, MN; Foxhome, MN; Prosper, ND, and St. Thomas, ND. At each location, two adjacent trials were planted. One was planted with a CR+ variety, Beta 7231 or Beta 8018 (St. Thomas location only) that had a 2-year-average 2.9 CLS rating (Brantner et al. 2025). At all four locations, a non-CR+ variety, Crystal 912, was planted, with a 2-year average CLS rating of 5.0 (Brantner et al. 2025). Standard seed treatments were used. Since a direct comparison of CR+ and non-CR+ sugarbeet varieties was not an objective of this project, plots were laid out in a randomized complete block design with four replications, with a separate trial for each variety. Each plot consisted of six 30-foot-long rows with 22-inch spacing. Planting dates for each location are provided in Table 1. Fungicide programs (treatments) were intended to mirror actual grower practices as much as possible while still providing comparative information between locations. No CLS inoculum was applied to these trials. Treatment information is provided in Table 2. The Renville location included an extra application (G or H) in order to follow local practices. The Prosper location did not have a G or H timing application due to late planting. The B timing was approximately row closure at each location. Fungicide programs were similar among the programs, and is outlined in Table 3. All fungicides were applied to the center four rows of each plot, using either a bike sprayer at 17 gallons per acre (gpa) or tractor-mounted sprayer applying 17 gpa (20 gpa for the Renville location). CLS severity was rated from mid-July to the end of the season using the scale developed by Jones and Windels (1991). The center two rows of each plot were rated. Area under disease progress curve (AUDPC) was calculated from CLS severity and allowed for comparison disease severity between plots (Simko and Piepho 2012).

Log transformation was conducted prior in order to meet model assumptions. Plots were harvested on in mid-September through early October (Table 1) using a custom 2-row plot harvester. The center two rows were harvested and used for yield calculations. Approximately 25 lbs of roots were arbitrarily selected and delivered to the American Crystal Sugar Company Quality Tare Laboratory, East Grand Forks, MN, and analyzed for sugar quality. The effect of treatment on AUDPS (following log transformations), root yield, and recoverable sugar per acre (RSA) was evaluated using a generalized linear mixed model. A Fishers protected least significant different test was used for mean separation at the $\alpha = 0.05$ level (Steel et al. 1997) in R version 4.2.3 (R Core Team 2023).

Table 1. Planting dates, seasonal rainfall totals, and Cercospora Risk DIVs (Daily Infection Value) for each month and the total season. DIV values were obtained from the North Dakota Agricultural Weather Network (NDAWN).

Location	Planting Date	Harvest Date	Approximate Rainfall (in.) (May 1st – September 30th)	Cercospora Risk (monthly cumulative DIVs[1])				Total cumulative DIVs
				June	July	August	September	
Renville, MN	April 26th	September 16th	26.0	26	77	80	35	218
Foxhome, MN	April 25th	September 22nd	18.8	20	69	69	31	189
Prosper, ND	May 27th	September 15th	13.0	20	46	56	16	138
St. Thomas, ND	May 7th	October 2nd	10.1	6	37	31	17	91

[1]DIV = Daily Infection Value, per the Sugarbeet Cercospora Risk Model utilized by the North Dakota Agricultural Weather Network.

Table 2. Treatment list and application timing of treatments for sugarbeet field trials conducted at four locations in eastern North Dakota and western and southern Minnesota in 2026.

Treatment	Program Start Date	Application Interval	Number of Applications	Application Dates[1]
1	Mid-June	10-14 days	6	A B C D E F[2]
2	Late June	10-14 days	5	B C D E F[2]
3	Late June	10-14 days then 21-28 days (“Extended”)	4	B C E G[3]
4	Early July	10-14 days then 21-28 days (“Extended”)	4	C D F H[4]
5	Early July	3-spray	3	C E G[5]
6 (Nontreated control)	-	-	0	-

[1]Application dates at Renville: A = June 21st, B = July 9th, C = July 16th, D = August 1st, E = August 11th, F = August 21st, G = August 29th, H = September 8th. Application dates at Foxhome: A = June 19th, B = July 1st, C = July 14th, D = July 25th, E = August 13th, F = August 28th, G = September 10th. Application dates at Prosper: A = June 27th, B = July 2nd, C = July 17th, D = July 31st, E = August 12th, F = August 26th. Application dates at St. Thomas: A = June 17th, B = June 27th, C = July 10th, D = July 24th, E = August 5th, F = August 19th, G = September 9th.

[2]The Renville location incorporated an additional G (or H) application to match regional practices for treatments 1 and 2.

[3]B C E F at Prosper

[4]C D F G at Foxhome and St. Thomas, C D F (G spray was omitted) at Prosper

[5]C E F at Prosper

Table 3. Fungicide programs used for a multi-location experiment conducted to evaluate Cercospora leaf spot control in sugarbeet in 2026 in Minnesota and North Dakota. The Renville site incorporated additional G and H applications due to local practices.

Treatment	Product @ Rate
1	A[1] = Proline @ 5.7 fl oz/A + Koverall @ 2 lbs/A B = Super Tin @ 8 fl oz/A + Topsin @ 20 fl oz/A C = Headline SC @ 12 fl oz/A + Koverall @ 12 fl oz/A D = Super Tin @ 8 fl oz/A + Koverall @ 2 lbs/A E = Inspire XT @ 7 fl oz/A + Koverall @ 2 lbs/A F = Super Tin @ 8 fl oz/A + Koverall @ 2 lbs/A G = Badge SC @ 2 pt/A + Koverall @ 2 lbs/A
2	B = Proline @ 5.7 fl oz/A + Koverall @ 2 lbs/A C = Super Tin @ 8 fl oz/A + Topsin @ 20 fl oz/A D = Headline SC @ 12 fl oz/A + Koverall @ 12 fl oz/A E = Super Tin @ 8 fl oz/A + Koverall @ 2 lbs/A F = Inspire XT @ 7 fl oz/A + Koverall @ 2 lbs/A G = Super Tin @ 8 fl oz/A + Koverall @ 2 lbs/A H = Badge SC @ 2 pt/A + Koverall @ 2 lbs/A
3	B= Proline @ 5.7 fl oz/A + Koverall @ 2 lbs/A C = Super Tin @ 8 fl oz/A + Topsin @ 20 fl oz/A E = Headline SC @ 12 fl oz/A + Koverall @ 12 fl oz/A G = Inspire XT @ 7 fl oz/A + Koverall @ 2 lbs/A
4	C = Proline @ 5.7 fl oz/A + Koverall @ 2 lbs/A D = Super Tin @ 8 fl oz/A + Topsin @ 20 fl oz/A F = Headline SC @ 12 fl oz/A + Koverall @ 12 fl oz/A E = Inspire XT @ 7 fl oz/A + Koverall @ 2 lbs/A
5	C = Proline @ 5.7 fl oz/A + Koverall @ 2 lbs/A E = Super Tin @ 8 fl oz/A + Topsin @ 20 fl oz/A G = Headline SC @ 12 fl oz/A + Koverall @ 12 fl oz/A
6 (Nontreated control)	-

[1]Application dates at Renville: A = June 21st, B = July 9th, C = July 16th, D = August 1st, E = August 11th, F = August 21st, G = August 29th, H = September 8th. Application dates at Foxhome: A = June 19th, B = July 1st, C = July 14th, D = July 25th, E = August 13th, F = August 28th, G = September 10th. Application dates at Prosper: A = June 27th, B = July 2nd, C = July 17th, D = July 31st, E = August 12th, F = August 26th. Application dates at St. Thomas: A = June 17th, B = June 27th, C = July 10th, D = July 24th, E = August 5th, F = August 19th, G = September 9th. The St. Thomas location incorporated the QoI fungicide, Headline, last to match regional practices.

RESULTS AND DISCUSSION

During the 2025 growing season, local environmental variability was observed through differences in rainfall, temperature, and humidty. Generally, there was a trend of increased rainfall and Cercospora DIVs in the two southern RRV locations, Renville and Foxhome. The St. Thomas location experienced both the least rainfall (10.1 inches) and the fewest cumulative DIVs for the season, 58% and 52% fewer cumulative DIVs than Renville and Foxhome, respectively (Table 1). Environmental conditions at Prosper were similar to the St. Thomas conditions, with 13.0 inches of rainfall during the growing season and 138 cumulative DIVs. Although none of the trials in this project were inoculated with *C. beticola* directly, the Renville and Foxhome trials were nearby inoculated CLS experiments and were located nearby commercial sugarbeet fields. Compared to the Prosper and St. Thomas sites, Renville and Foxhome were judged to be “high-risk” for CLS symptom development due to both environmental history and CLS epidemics in the region, historically. Indeed, in 2025 the average CLS rating (both CR+ and non-CR+ varieties, combined) was 3.7 at Prosper and 3.8 at St. Thomas, but 5.3 and 5.7 for Renville and Foxhome, respectively. These values include both the best- and least-performing treatments, indicating similar patterns in treatment effect but different background levels of disease development. Although trends in CLS severity were similar between both CR+ and non-CR varieties, separate analysis was required to meet statistical assumptions.

At both of Renville and Foxhome locations, the mid-June program start was less effective at reducing CLS severity than the late-June start (Tables 4 and 5). However, this was only a significant effect at the Renville location, and there was no statistically significant different in RSA between these treatments at any location. Based on this single year of data, there is no evidence to support fungicide applications earlier than the final 10 days of June. In the locations were CLS pressure was relatively low (Prosper and St. Thomas), the effect of treatment on yield and RSA not significant, with the exception of the non-CR+ variety at Prosper. Notably, treatments that began at row closure (late June) were all statistically similar in terms

of disease control, yield, and RSA even with the extended interval in treatment 3 (Table 4 and 5). Future experiments may evaluate whether one or two late June or early July fungicide applications may provide enough control to offer flexibility of timing subsequent applications, at least in the northern RRV under normal to below-normal rainfall.

ACKNOWLEDGEMENTS

This work would not have been possible without the collaboration of many individuals and companies. The authors would like to acknowledge sugarbeet seed companies, chemical manufacturers and supplier for providing seed and crop protection products, Etzler Farms, American Crystal Sugar Company, East Grand Forks Tare Lab, and NDSU Sugarbeet Extension collaborators. Technical expertise was provided by Peter Hakk, Adam Aberle, Bryce Friday, Isaac Zatechka, Noah Stommes, Beau Johnson

Table 4. Effect of fungicide program start date and interval on Cercospora leaf spot disease severity (area under the disease progress curve, AUDPC), yield, and recoverable sugar per acre (RSA) in trials conducted at four locations in Minnesota and North Dakota in 2025.

Location / Variety	Treatment, Program start date/ Intervals[1]	CLS Severity log(AUDPC)[2]	Yield (tons/A)	RSA[3] (lbs)
Renville/ CR+	1) Mid-June / Standard	5.1 b[4]	27.2 a	7,170 a
	2) Late June / Standard	4.9 a	26.9 a	7,169 a
	3) Late June / Extended	5.3 c	25.4 a	6,578 ab
	4) Early July / Extended	5.2 bc	25.6 a	6,547 ab
	5) 3-spray	5.3 c	24.0 ab	6,131 b
	6) Nontreated control	5.8 d	20.8 b	4,802 c
	P =	< 0.001	0.004	< 0.001
Foxhome/ CR+	1) Mid-June / Standard	3.0 a	32.4 abc	9,037
	2) Late June / Standard	2.9 a	34.5 a	9,472
	3) Late June / Extended	3.8 b	32.9 abc	8,761
	4) Early July / Extended	3.7 b	33.7 ab	9,469
	5) 3-spray	3.7 b	31.5 bc	8,767
	6) Nontreated control	4.6 c	30.9 c	8,603
	P =	< 0.001	0.015	NS[5]
Prosper/ CR+	1) Mid-June / Standard	3.1 a	28.6	8,609
	2) Late June / Standard	3.6 b	28.1	8,657
	3) Late June / Extended	3.5 ab	28.9	9,014
	4) Early July / Extended	3.6 b	29.1	9,149
	5) 3-spray	3.8 b	28.7	8,894
	6) Nontreated control	4.5 c	26.1	8,263
	P =	< 0.001	NS	NS
St. Thomas/ CR+	1) Mid-June / Standard	3.4 a	41.8	12,932
	2) Late June / Standard	3.7 ab	41.5	12,878
	3) Late June / Extended	4.0 b	39.6	11,997
	4) Early July / Extended	3.7 ab	41.7	12,488
	5) 3-spray	4.1 b	41.0	12,321
	6) Nontreated control	4.7 c	37.8	11,367
	P =	< 0.001	NS	NS

[1]Standard = 10-14 days; Extended = 10-14 days, then 21-28 days
[2]Area Under the Disease Progress Curve. AUDPC values were log transformed prior to mixed-model statistical analysis.
[3]Recoverable Sugar per Acre
[4]Means in the same column that share a letter are not significantly different ($\alpha = 0.05$).
[5]Not Significant

Table 5. Effect of fungicide program start date and interval on Cercospora leaf spot disease severity (area under the disease progress curve, AUDPC), yield, and recoverable sugar per acre (RSA) in trials conducted at four locations in Minnesota and North Dakota in 2025 on non-CR+ sugarbeet.

Location / Variety	Treatment, Program start date/ Intervals[1]	CLS Severity log(AUDPC)[2]	Yield (tons/A)	RSA[3] (lbs)
Renville/ non-CR+	1) Mid-June / Standard	5.2 b[4]	24.3 a	5,767 a
	2) Late June / Standard	5.0 a	23.6 a	5,994 a
	3) Late June / Extended	5.4 c	23.7 a	5,354 ab
	4) Early July / Extended	5.5 d	20.2 ab	4,726 b
	5) 3-spray	5.6 d	23.0 a	5,173 ab
	6) Nontreated control	5.8 e	17.1 b	3,387 c
	P =	< 0.001	0.004	< 0.001
Foxhome/ non-CR+	1) Mid-June / Standard	5.6 a	30.4	7,361
	2) Late June / Standard	5.5 a	29.6	6,960
	3) Late June / Extended	5.8 b	27.7	6,155
	4) Early July / Extended	5.8 b	27.4	6,120
	5) 3-spray	5.8 b	29.8	6,656
	6) Nontreated control	6.1 c	24.7	5,069
	P =	< 0.001	NS[5]	NS
Prosper/ non-CR+	1) Mid-June / Standard	3.0 a	32.4 abc	9, 037
	2) Late June / Standard	2.9 a	34.5 a	9,472
	3) Late June / Extended	3.8 b	32.9 abc	8,761
	4) Early July / Extended	3.7 b	33.7 ab	9,469
	5) 3-spray	3.7 b	31.5 bc	8,797
	6) Nontreated control	4.6 c	30.9 c	8,604
	P =	< 0.001	0.015	NS
St. Thomas/ non-CR+	1) Mid-June / Standard	3.1 a	36.1	11,545
	2) Late June / Standard	3.4 a	34.3	11,072
	3) Late June / Extended	3.4 a	38.9	12,681
	4) Early July / Extended	3.6 a	39.4	13,108
	5) 3-spray	3.5 a	36.9	11,923
	6) Nontreated control	4.7 b	34.8	10,855
	P =	< 0.001	NS	NS

[1]Standard = 10-14 days; Extended = 10-14 days, then 21-28 days
[2]Area Under the Disease Progress Curve. AUDPC values were log transformed prior to mixed-model statistical analysis.
[3]Recoverable Sugar per Acre
[4]Means in the same column that share a letter are not significantly different ($\alpha = 0.05$).
[5]Not significant

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EARLY DETECTION OF *CERCOSPORA BETICOLA* ASYMPTOMATIC INFECTION IN COMMERCIAL SUGARBEET FIELDS IN 2025

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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) of Minnesota and North Dakota. 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 with the sole exception being the ethylene bisdithiocarbamate (EBDC) fungicides.

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. Results from field surveys of asymptomatic leaf samples from commercial sugarbeet fields show 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 2025.

OBJECTIVES

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

METHODS AND MATERIALS

From 2021 - 2025, 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 – 2025, 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 4% in recoverable sucrose per acre on average. This trend was more pronounced in years with higher CLS pressure as exemplified by data from the year 2020 (Figure 2).

SUMMARY

Across five sampling years, a 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 paramount 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.

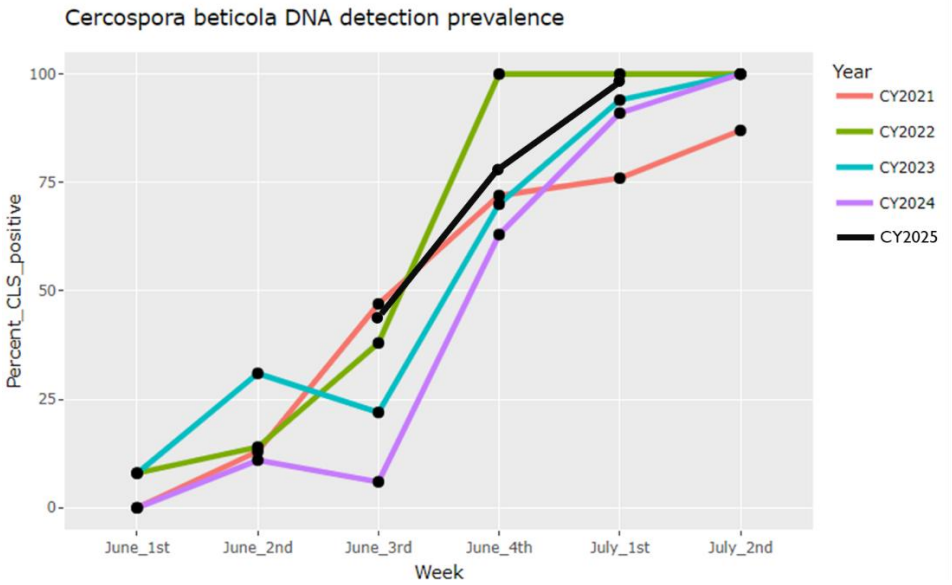
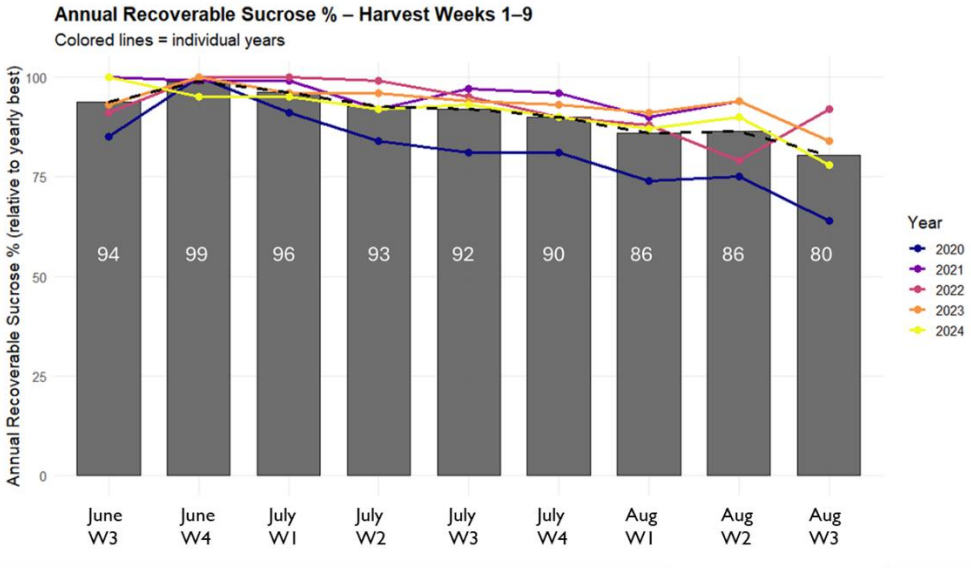


Figure 2: Average recoverable sucrose per acre (RSA) in commercial sugarbeet fields. Fields were binned into weekly bins based on the week in which fungicide applications began. Each yearly dataset was normalized by setting the highest value to 100 and applying a relative score to the highest value. 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 2020 – 2024. Each bar has a numerical designation in white which represents the average performance of each weekly bin across the years examined.



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. [Carophyllales: Amaranthaceae]). Significant losses can occur under warm and humid environments (Lartey et al., 2010; Skaracis et al., 2010), with yield losses reaching 50% in addition to the negative impact on sugar extraction from roots of infected plants (Francis & Luterbacher, 2003; Rangel et al., 2020). Application of host resistance for CLS control would be more effective with a lower cost (Smith and Gaskill, 1970). For example, Vogel et al. (2018) found that breeding efforts have enabled recent CLS resistant cultivars to achieve comparable yield performance to that of susceptible varieties, and resistant cultivars therefore have relatively improved economic performance since reduced fungicides need to be applied. Therefore, it is vital to identify and pyramid novel resistance genes from different genetic sources to enable long-lasting resistance and maintain the sustainability of the crop.

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 focused on identifying CLS resistance from both sugarbeet and wild sea beet from publicly available germplasm lines. We will then conduct genome-wide association study (GWAS) to detect genomic regions associated with CLS resistance and reveal if different resistance genes present in wild and cultivated *Beta vulgaris* germplasm, which will be used to determine strategy of combining CLS resistance for new breeding line development. In this report, we focus on reporting CLS evaluations conducted in past three years 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 36 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 Min-Dak Farmer's Cooperative nurseries, 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. Inoculation was performed in mid-July 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 late September to early October each year 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	No. of accession	Country	No. of accession
Belgium	1	Morocco	32
Croatia	1	Portugal	6
Cyprus	1	Russian	1
Denmark	1	Sardinia	2
Egypt	19	Sicily	2
France	58	Spain	6
Germany	1	Tunisia	1
Greece	44	Turkey	5
India	2	UK	13
Ireland	11	USA	10
Israel	1	Unknown	1
Italy	81		

Table 2. List of 36 sugarbeet lines used for Cercospora leaf spot (CLS) resistance evaluation.

Entry	Description
25-1	Selection from SP 69550
25-2	Selection from EL44cms/SP 69550
25-3	Selection from FC712/C562cms
25-4	Selection from F1012/SP69550-01
25-5	Selection from CFM94/961009H2
25-6	Selection from SP69550-0/F1015
25-7	Selection from F1015/961009H2
25-8	Selection from SP69550-01/F1016
25-9	Selection from FC504cms/F1015
25-10	Selection from F1010/SP69550-01
25-11	Selection from F1015/951013
25-12	Selection from F1010 / SP69550-01 (cms)
25-13	Selection from FC607cms/F1001
25-14	Selection from SP69260/F1014
25-15	Selection from SP69550/L19
25-16	selection from SP8030-0
25-20	Selection from ND PI mixture
25-22	Selection from BW sugarbeet
25-23	Selection from FC709-2
25-24	Selection from SP69550-2
25-25	EL50
25-26	Selection from SP69550/L19
25-32	Selection from CL24-sugarbeet
25-33	Selection from CIM mix/Y577
25-35	Selection from FC607 cms/F1001
25-36	Selection from EL44CMS X SP69550
25-37	Selection from SP69269-01 X F1011
25-38	Selection from SP6926CMS X F1013
25-39	Selection from FC712/SP69550-01
25-40	Selection from F1015/961009H2
25-41	Selection from F1015/951013
25-42	Selection from F1015/SP69550-01 (cms)
25-43	Selection from F1010/SP69550-01 (cms)
25-44	Selection from F1013/SP69550-01
25-45	Selection from F1010/FC504cms
25-46	Selection from F1010/SP69559-01

For CLS evaluations, the categorical CLS ratings of each accession collected in one experiment (defined as one location in each year) were averaged, and the mean ratings from that experiment were treated as one replication for statistical analysis conducted using the R package *agricolae*. Accession was considered as a fixed effect and environments as a random effect. Histograms of CLS resistance and SBRM tolerance distributions in 300 *B. maritima* accessions were generated using Microsoft Excel.

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 subgroups were obtained after regrouping according to morphological traits within accessions, and uniformity of plants within each plant type was obviously improved (Fig. 1).

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

Field plots at Foxhome in 2022 were seriously affected by drought, which led to light CLS infection, data of that environment were thus excluded from the analysis. CLS developed normally in 2023 and 2024 with severe infections in susceptible checks observed at all locations in Fargo, ND; Foxhome and Min-Dak Farmer's Cooperative nurseries, MN. In total, data were collected from six environments accordingly designated as Foxhome23, Mindak23, Fargo23, Foxhome24, Mindak24 and Fargo24. Disease severity distribution in each environment did not follow a normal distribution pattern, with over 50% of subgroups showing easily observed disease symptoms and receiving ratings of 6 or greater (Fig. 2). Variance analysis indicated that both B. maritima subgroups and environments were highly significant ($P < 0.001$) (Table 3) indicating that both host resistance and environmental conditions play significant roles during disease development.

Table 3. Analysis of variance for Cercospora leaf spot (CLS) and sugarbeet root maggot (SBRM) evaluation data collected in 388 *B. maritima* subgroups under multiple environments.

Source of variance	Degree of freedom	F-Value	Significance
Accessions	387	3.426	$P < 0.001$***
Environment	5	83.095	$P < 0.001$***
Residuals	1935		

When combining data from all six environments, a total of 42 accessions (comprised of 46 subgroups with 24 annual and 22 biennial) were considered resistant to CLS as they consistently showed fewer disease symptoms across all environments, with average severity ratings of 3 or lower (Table 4). According to *B. maritima* clusters defined using the method of non-model-based discriminant analysis of principal components (DAPC) in Tehseen et al. (2024), these accessions were found in almost all clusters except Cluster 7, which included accessions collected from the beaches of the east Mediterranean Sea in Turkey, Egypt and islands in southern Greece. Among the resistant accessions, 24 and 18 accessions were from clusters that were genetically close (clusters 2, 3, 4 and 6) and distinct (clusters 1, 5 and 8) to cultivated beets, respectively. Among the 18 accessions that were from genetically distinct clusters, 7, 6 and 5 were from clusters 1 (collected from northern and western Europe), 5 (collected from northern and western Europe) and 8 (collected from Morrocco), respectively.

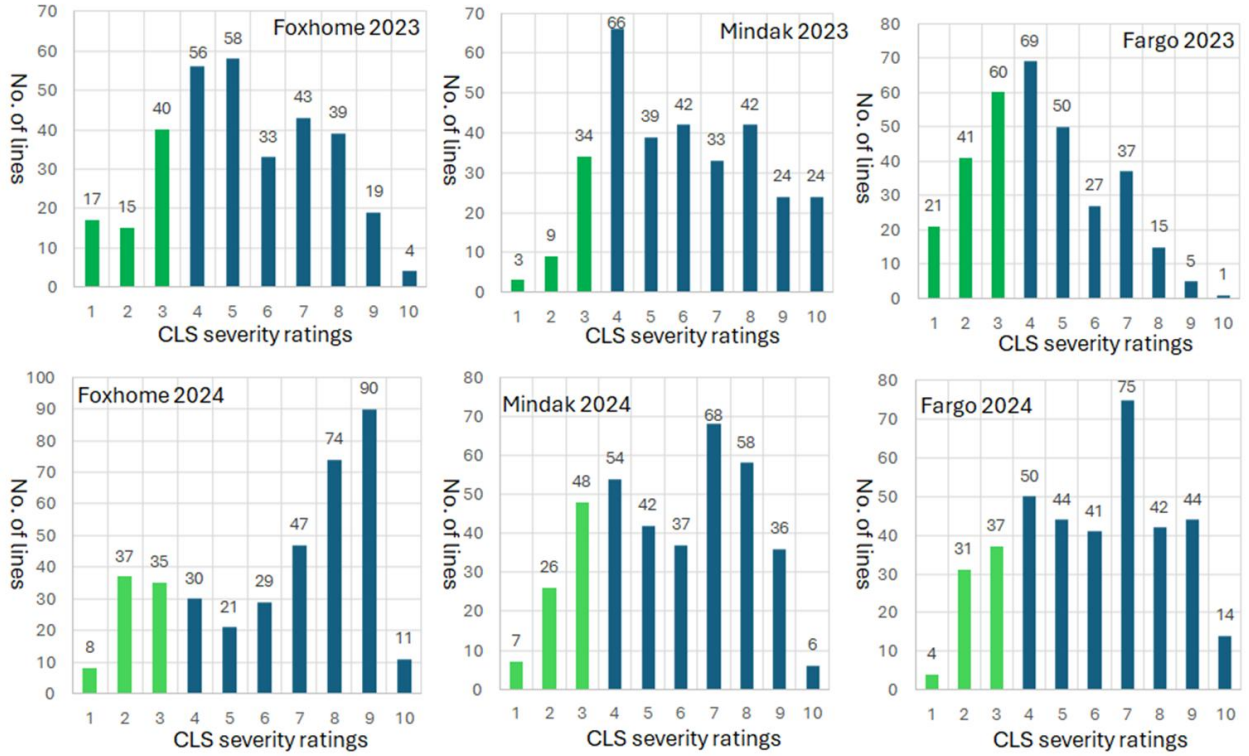

Fig. 2. Distribution of Cercospora leaf spot (CLS) ratings in 393 *B. maritima* plant types evaluated in field nurseries during 2023 to 2025. Light green color indicates accessions with CLS ratings of 3 or less.

Table 4. List of 42 *Beta maritima* accessions with resistance to Cercospora leaf spot (CLS) caused by *Cercospora beticola*.

Accession name[a]	Accession phenotype	Sub-population[b]	Origin	Average CLS ratings[c]	Standard Deviation
PI 540694	Biennial	1	France	2.9	±0.2
PI 518344	Biennial	1	United Kingdom	2.7	±0.6
PI 518312	Biennial	1	United Kingdom	2.7	±1.1
PI 518342	Annual	1	United Kingdom	2.6	±0.9
PI 540691	Annual	1	France	2.7	±0.9
PI 540625	Biennial	1	France	2.7	±0.5
PI 518398	Biennial	1	Ireland	2.9	±0.4
PI 504205	Biennial	2	Italy	2.8	±0.6
PI 504172	Annual	2	Italy	2.4	±0.7
PI 546399	Annual	2	Italy	2.9	±0.7
PI 546539	Biennial	2	Greece	2.6	±0.3
PI 546538	Annual	2	Greece	2.8	±0.5
PI 546538	Biennial	2	Greece	2.9	±0.2
PI 504253	Biennial	2	Italy	2.9	±1.0
PI 540565	Annual	2	France	3.0	±0.6
PI 504177	Annual	2	Italy	2.5	±0.9
W6 45840	Annual	3	Morocco	2.7	±1.0
PI 604540	Biennial	3	Spain	2.6	±0.4
PI 546393	Biennial	3	United States	2.5	±0.4
PI 504249	Annual	4	Italy	2.9	±0.7
PI 504254	Annual, Red root	4	Italy	2.8	±0.2
PI 504254	Annual, White root	4	Italy	3.0	±0.3
PI 504190	Biennial	4	Italy	2.9	±0.4
PI 504211	Annual	4	Italy	3.0	±0.5
PI 546424	Annual	4	Greece	3.0	±0.6
PI 540574	Biennial	4	France	2.4	±1.0
PI 504241	Biennial	4	Italy	2.8	±0.6
PI 504241	Annual	4	Italy	2.9	±0.2
PI 546431	Biennial	4	Greece	2.6	±0.8
PI 504201	Annual	4	Italy	2.9	±0.2
PI 504208	Annual	4	Italy	2.8	±0.6
PI 546519	Biennial	4	Greece	2.9	±0.2
PI 518320	Annual	5	United Kingdom	3.0	±0.4
PI 540609	Biennial	5	France	2.9	±0.2
PI 518315	Biennial	5	United Kingdom	2.5	±0.6
PI 540580	Biennial	5	France	2.8	±0.5
Ames 8448	Biennial	5	Ireland	2.9	±0.2
PI 540573	Annual	5	France	2.8	±0.2
W6 45825	Annual	6	Morocco	2.4	±0.7
W6 45823	Annual	6	Morocco	2.9	±0.7
PI 604528	Biennial	6	Spain	2.4	±0.8
W6 44496	Annual	8	Morocco	3.0	±0.5
W6 44497	Biennial	8	Morocco	1.9	±0.5
W6 44497	Annual	8	Morocco	2.8	±1.0
W6 44503	Annual	8	Morocco	2.9	±0.6
W6 44499	Annual	8	Morocco	2.8	±0.6

[a]Plant name of each accession was according to USDA-GRIN (Germplasm Resources Information Network).
[b]Sub-population structure of *Beta maritima* was according to Tehseen et al. (2024) that grouped accessions into 8 clusters with the cluster 6 mainly includes the cultivated beets, and clusters 2 and 4 have *B. maritima* accessions are genetically closer to the cultivated sugarbeet lines.
[c]Average disease severity ratings were calculated from data collected in six environments (Fig. 1) by using a 0 – 10 scale with 0 as immune (no CLS spots), 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 - 10 as susceptible (diseased leaf has 50 - 100% of area necrosed on most plants of the row) (Ruppel and Gaskill, 1971).

CLS evaluation in sugarbeet selections

Sugarbeet lines from previous selection all showed much slighter disease than the susceptible check (Fig. 4) though segregations were shown in some selections, indicated CLS resistance was mostly genotype-depended and selection based on resistance is an effective way to maintain the resistance. Therefore, the selected lines are very useful to form an association mapping panel to identify genetic factors controlling the resistance. If CLS resistance in wild sea beet is different from the resistance in cultivated sugarbeet, and cross between resistant plants from two sub-species will be conducted to pyramid resistance genes to let resistance stable and last longer. Genotyping of the sugarbeet lines and sea beet accessions are ongoing now and GWAS will be conducted right after genotyping. Combining resistance or introgression of resistance from sea beet into sugarbeet is on the schedule.

Fig. 4. Example of plants in selected sugarbeet breeding lines with excellent Cercospora leaf spot (CLS) resistance compared to the susceptible check. Photos were taken in 2025 at Foxhome, MN.

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IDENTIFYING GENETIC SIGNATURES OF CERCOSPORA BETICOLA ADAPTATION TO CRPLUS SUGAR BEET VARIETIES

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Management of Cercospora leaf spot (CLS) typically relies on a combination of cultural practices, moderate host resistance, and fungicide applications. Historically sugar beet resistance to *C. beticola* has been conditioned by four quantitative trait loci (QTL) (Smith and Gaskill, 1970; Nilsson et al. 1999; Setiawan et al. 2000; Taguchi et al. 2011). Wild sea beet is a reservoir of genetic diversity and has been a critical source of genetic diversity leveraged to introgress new traits into cultivated sugar beet (Smith and Campbell 1996). Due to the difficulty of developing durable *C. beticola* resistance, CLS is largely managed by the timely application of fungicides throughout the growing season.

C. beticola has shown a staggering ability to adapt to management practices largely due to its polycyclic nature and high sporulation rate (Rangel et al. 2020). The emergence of fungicide resistance in *C. beticola* populations serves as a primary example of the pathogen's ability to adapt quickly to management practices (Secor et al. 2010). Understanding the molecular basis of fungicide resistance can help with the understanding of how *C. beticola* adapts to management practices and can be used to inform future use of fungicides to avoid the resistance from developing.

In recent years, CLS resistant sugar beet varieties carrying the CR+ trait conditioned by the *BvCR4* resistance gene have increased in popularity. This new resistance has been a valuable tool for integrated disease management. However, like fungicides, there is a risk that *C. beticola* populations will adapt to this new resistance. Already, our group has obtained a large collection of *C. beticola* isolates that have been subjected to whole genome sequencing from each of 2016, 2017, 2021, and 2023. Preliminary analysis have identified genes under CR+ adaptation selection pressures and greenhouse assays show that isolates exhibit significant symptoms of CLS.

In 2024, reports of local CLS epidemics in fields planted with CR+ varieties were observed and this is the first severe outbreak reported on CR+ varieties in the RRV. Though unfortunate, isolates collected from these outbreaks present an opportunity to examine the genetic underpinnings of CR+ adaptation on a wide population level scale.

Objectives:

1. Sequence *C. beticola* isolates collected in the RRV in 2024
2. Perform population genetic analysis of populations collected in the RRV from 2016 – 2024 to characterize population shifts associated with CR+ adaptation.

Materials and Methods:

A clone corrected isolate population collected in 2024 will be subject to WGS through a prearranged sequencing contract with Novogene USA. Each sequenced isolate genome will be aligned to the currently available *C. beticola* reference genome to identify mutations prevalent in the population through already established bioinformatics pipelines designed by Dr. Wyatt.

Identified mutation will be used in population genetic analysis to identify regions of the genome undergoing selection pressures associated with CR+ adaptation. Preliminary findings from 2021 revealed a population bottleneck where isolates collected from CR+ sugar beet varieties represented a small subpopulation compared to the RRV population at large. From isolates belonging to the bottlenecked subpopulation, we identified genomic regions with genes potentially involved in CR+ adaptation. The addition of the already available sequencing data from 2023 and the addition of sequencing data from 2024 will provide the necessary power to narrow down the specific genetic associations underpinning CR+ adaption.

Results and Discussion:

To identify signatures of adaptation to CR+ mediated CLS resistance in the C. Beticola population present in the RRV, A collection of isolates from the 2024 growing season were selected for whole genome sequencing. Isolates were selected to evenly distribute sampled locations across the entire RRV growing region so as to avoid regional bias and potentially confounding population structure. A population consisting of isolates collected between the years of 2016 and 2023 was readily available with whole genome sequencing data already acquired.

Following whole genome sequencing, mutation identification was performed and identified over 1 million single nucleotide polymophisms that were filtered to a final set of 10,000 high confidence, unlinked genetic markers with an even distribution throughout the C. Beticola reference genome. A principle component analysis was performed to examine the population structure of isolates collected across the 2016-2024 period and population stratification using the year of collection to compare patterns of annual population structure distributions. Results from this analysis showed that in the years 2016 and 2017 the population structure was stable and produced a similar structural pattern. In 2021, PCA revealed a divergent lineage of C. Beticola isolates that correlated with the commercial deployment of sugar beet varieties containing the BvCR4 mediated resistance trait CR+. Subsequent sequencing efforts from 2023 and 2024 showed a strengthening of this population trend that further correlates with the wider adoption of the CR+ sugar beet varieties and potentially indicates that the population has experienced a major shift induced by the selection pressure imposed by the new sugar beet resistance (Figure 1).

Recent results from the Bolton and Wyatt Labs at the USDA-ARS Sugarbeet Research Unit have identified and partially characterized the C. Beticola gene AvrCR4 as the critical gene recognized by the CR+ resistance gene BvCR4. The loss of AvrCR4 from C. Beticola isolates allows the pathogen to circumvent CR+ resistance. Armed with this new knowledge we examined the whole genome sequenced populations collected from 2016-2024 and identified the proportion of isolates lacking AvrCR4 in each year. In 2016 and 2017, no isolates were identified that lacked the AvrCR4 gene, indicating that the populations present in the RRV in those years were not adapted to CR+ resistance. From 2021 -2024, we report an increasing frequency of C. Beticola isolates having lost the AvrCR4 gene and thus characterized as CR+ adapted isolates (Table 1).

Summary:

Through the use of whole genome sequencing of C. Beticola populations collected annually in the RRV, we successfully identified population structural shifts that corresponded to C. Beticola adaptation to the recently deployed CR+ sugar beet CLS resistance gene BvCR4. By sequencing isolates across the span of 2016 to 2024, we show that the frequency of adapted isolates increase over time and in response to the increased frequency of acreage planted with CR+ sugar beets. This work highlights the utility of leveraging molecular techniques to monitor pathogen populations to rapidly identify adaptation to management practices and future work will focus on rapidly acquiring this data to proactively forecast the impact of adapted pathogen populations.

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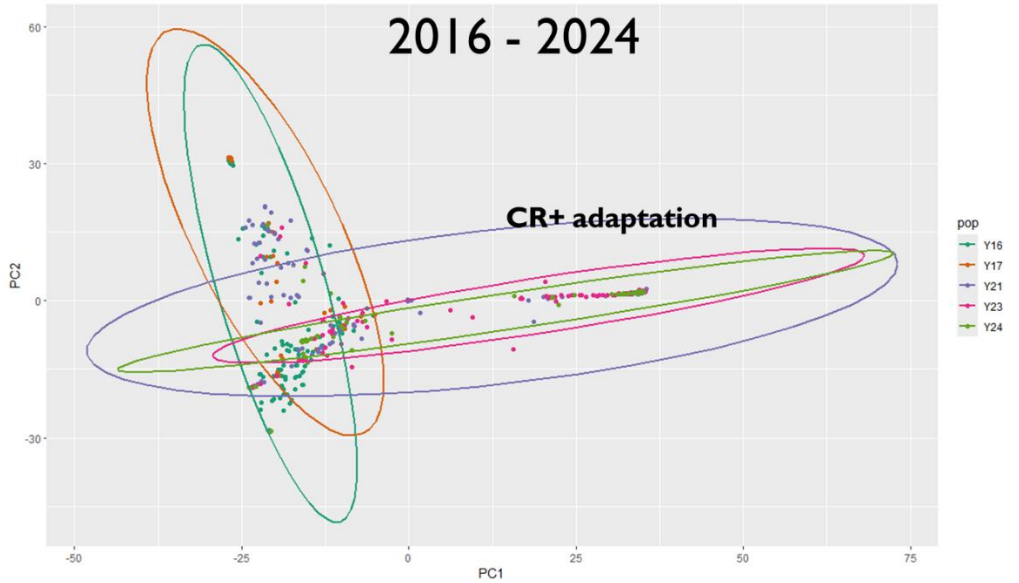
Table 1: Percentage of isolates collected and subject to whole genome sequencing that are adapted to the CR+ trait as determined by the loss of the *Cercospora beticola* effector AvrCR4.

Year	Percent
2017	0%
2016	0%
2021	11%
2023	37%
2024	76%

Figure1: PCA of C. beticola populations collected from 2026 to 2024 showing divergent lineages extending on the right side of the plot from isolates collected from 2021-2024 following the release of CR+ containing sugar beet varieties.



PATHOGENICITY ASSESSMENT AND GENOMIC CHARACTERIZATION OF BACTERIAL LEAF SPOT ISOLATES FROM SUGARBEET LEAF SAMPLES IN 2025

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INRODUCTION

Bacterial leaf spot (BLS) is a damaging foliar disease, primarily caused by *Pseudomonas syringae* and *Xanthomonas campestris*, two gram-negative bacterial pathogens capable of infecting lettuce, cucurbits, tomatoes, capsicum, beets, spring onions, and other crops (Xin et al. 2018; Gaetán and López 2005; Saxena et al. 2020). These pathogens enter plant tissues through stomata, hydathodes, or wounds and colonize the mesophyll parenchyma, where they release type III effector proteins that suppress salicylic-acid-mediated defense signaling (Üstün et al. 2013; Xin et al. 2018). As bacterial populations expand, cells emerge onto the leaf surface where they disperse by rain or wind, increasing epidemic potential (An et al. 2019; Moreira et al. 2014). Seedborne transmission further enables long-distance spread and recurrent outbreaks (An et al. 2019). Symptoms of BLS typically develop as water-soaked lesions surrounded by chlorosis, progressing to necrosis driven by plant immune responses or bacterial phytotoxins (Osdaghi et al. 2021; Abrahamian et al. 2020). Environmental conditions play a major role in disease progression; warm temperatures (20-30°C) and high humidity create optimal conditions for rapid symptom development (Vidaver and Lambrecht 2004; Gaulke and Goldman 2022).

Historically, BLS has been documented for over a century, with early descriptions reported in nasturtium and sugar beet in the early 1900s (Journal of Agricultural Research 1913). Recent decades have seen increasing outbreaks, expanded host ranges, and the emergence of antibiotic resistance. For example, new lineages of *Xanthomonas perforans* have recently caused severe outbreaks in peppers (Subedi et al. 2023), while the strAB streptomycin-resistance gene now occurs across several major plant pathogens including *P. syringae* and *X. campestris* (Sundin and Wang 2018). Management strategies such as application of copper and streptomycin sprays, and seed treatments with heat or chemicals, are becoming less effective as resistance increases (Cooksey 1990; Pernezny et al. 2002; Macnish 1965). Given this trend, there is a critical need for improved genomic characterization and pathogenicity validation of emerging BLS-associated bacteria. In this study, bacteria were isolated from symptomatic sugarbeet leaf samples, tested for their pathogenicity using controlled inoculation assays, and whole-genome sequencing and phylogenetic analysis were performed to identify species and evolutionary relationships. The resulting dataset provides insights into the pathogenic potential and genomic identity of these field-recovered bacterial isolates.

OBJECTIVES

The objectives of this study were to 1) conduct preliminary phylogenic analyses to determine genus-level identification of 34 bacterial isolates collected from leaf samples submitted to the Sugarbeet Plant Pathology lab in 2024; 2) carry out a trial within a controlled environment chamber to assess the pathogenicity of 20 bacterial isolates using three sugar beet cultivars; and 3) perform whole genome sequencing of the 20 isolates used in the pathogenicity assay to determine species level identification.

MATERIALS AND METHODS

Bacterial isolation and preliminary phylogenetics. A total of 14 leaf samples exhibiting BLS-like symptoms (Fig. 1) were submitted to the Sugar Beet Plant Pathology Laboratory between July and August 2024 (Table 1). Leaf spots that lacked visible fungal sporulation were tested for bacterial streaming by submerging symptomatic tissue in ultrafiltered deionized water and observing for exudate under a stereomicroscope. Suspect lesions were then excised, surface-sterilized in 0.5% sodium hypochlorite (NaOCl) for 1 m, rinsed thrice with sterile deionized water (SDW), and homogenized in 0.05M potassium phosphate buffer within 2 mL microcentrifuge tubes containing five 3 mm-glass beads using a FastPrep-24 homogenizer (MP Biomedicals). After incubation at room temperature for 10 m, the suspension was diluted 1:10 in SDW and streaked onto nutrient broth yeast extract (NBY) agar amended with cycloheximide (750 mg L^{-1}) to obtain single bacterial colonies. Single-colony cultures were grown in nutrient broth in 15 mL sterile conical tubes at 28°C on a shaker

overnight prior to genomic DNA (gDNA) extraction. After 48 hours, saturated liquid cultures were combined 1:2 with glycerol solution (65% glycerol, 0.1 M $MgSO_4$, 25 mM Tris-Cl, pH 8.0) and stored at -80°C in 2 mL cryovials. Genomic DNA was extracted using the Wizard Genomic DNA purification kit (Promega) following the manufacturer's protocol. The concentration of gDNA was evaluated using Qubit 3.0 fluorometer using the high sensitivity assay kit and gDNA quality was assessed with a NanoDrop spectrophotometer.

Isolates were subjected to targeted sequencing of the *16S-23S* ribosomal RNA (rRNA) intergenic region (Guasp et al. 2000; Jensen et al. 1993) and housekeeping genes sigma factor 70 subunit, *rpoD*; and gyrase B, *gyrB* (Sarkar and Guttman 2004) for genus-level characterization. PCR reactions were performed in a total volume of 30 µL and consisted of 3 ng gDNA, 2X GoTaq Colorless Master Mix (Promega), 10 µM of forward and reverse primers. Amplifications were carried out on a Bio-Rad T100™ Thermal Cycler. The PCR conditions for the *16S-23S* rRNA primers were 94°C for 5 m for initial denaturation, followed by 30 cycles of denaturation at 94°C for 1 min, annealing at 55°C for 1 min, and extension 72°C for 2 min, with a final extension at 72°C for 10 min. The PCR conditions for the *rpoD* primers were 94°C for 3 m for initial denaturation, followed by 30 cycles of denaturation at 94°C for 2 m, annealing at 62°C for 30 s, and extension 72°C for 1 min, with a final extension at 72°C for 5 m. The PCR conditions for the *gyrB* primers were 94°C for 5 m for initial denaturation, followed by 35 cycles of denaturation at 94°C for 2 min, annealing at 63°C for 1 min, and extension 72°C for 1 min, with a final extension at 72°C for 5 min. All amplified DNA products were loaded on 1.5% agarose gel amended with 1X GelRed nucleic acid stain (Millipore, USA) to confirm PCR amplification.

The amplified DNA products were submitted to Molecular Cloning Laboratories (South San Fransico, CA) for PCR clean-up and Sanger sequencing. Sequence chromatograms were reviewed, reads were manually trimmed, and forward and reverse sequences were aligned in BioEdit v7.7.1. Contiguous sequences were compared to the NCBI database using the Nucleotide Basic Local Alignment Search Tool (BLASTn), optimized for highly similar sequences. Reference sequences with high similarity were downloaded from NCBI to be included in the phylogenetic analysis. Phylogenetic analyses were performed in R (v4.4.3; R Core Team 2025). FASTA files were imported using Biostrings (v2.74.1; Pagès et al. 2024). Sequences were oriented and aligned using DECIPHER (v3.2.0; Wright 2016), and pairwise genetic distances were calculated using seqinr (v4.2-36; Charif and Lobry 2007). Phylogenetic trees were constructed using phangorn (v2.12.1; Schliep 2011) with the UPGMA algorithm and visualized using ggtree (v3.14.0; Guangchuang et al. 2017). Based on the preliminary phylogenetic placement and survivability after storage, 20 representative isolates were selected for pathogenicity assays and whole genome sequencing.

Pathogenicity assays. Three sugar beet cultivars, Crystal 912, Crystal 260, and Betaseed 8018, were planted in triplicate for each bacterial isolate, along with two negative controls, a nontreated control (NTC) and a mock control (MC). All seeds were commercially treated with seed treatments of Tachigaren (45g/ unit), Kabina (14g/unit), and standard rates of Allegiance, Thiram, and Poncho Beta. Ten seeds were planted per plastic pot (4.5 x 4.5 x 4 inches); plants were thinned to five plants per pot at the two-leaf stage. Pots were placed in a controlled growth chamber set to maintain 65% relative humidity with a 14-hour photoperiod using LED grow lights (LumiGrow) at 25 + 2 °C and watered approximately every other day.

This experiment was conducted as a series of three sequential pathogenicity assays, each structured as a split-plot design. A split-plot layout was used to account for possible differences within the growth chamber (e.g., differences in light intensity and airflow between positions). Isolates were blocked by replicate, and cultivars were used as whole plots to minimize environmental effects associated with specific chamber positions. In the first assay, 10 isolates were evaluated; a second assay evaluated an additional 10 isolates using the same design. Based on disease severity results from assays 1 and 2, the 10 most virulent isolates were re-evaluated in a third assay to confirm pathogenicity. The total number of infiltrations per isolate (across one or two assays) is reported in Table 2.

Cultures retrieved from storage were streaked onto NBY agar and incubated for 48 hours at 28°C. A single colony was streaked onto new NBY agar and incubated for 48 hours at 28°C. Six milliliters of SDW was added to each plate, cells were dislodged using a stainless-steel spreader, and the suspension was collected into 15 mL sterile conical tubes and adjusted to a final volume of 10 mL with SDW. Bacterial suspensions were quantified using a spectrophotometer with 200 µL per cuvette and diluted to an optical density of OD_{600} = ~0.9, corresponding to approximately 1 x 10^8 colony forming units (CFU) per mL. The number of CFUs was determined by further dilution (1:100,000) into SDW and spreading 100 µL of the suspension onto NBY agar. Following an incubation period of 48 hours at 28°C, individual colonies were manually counted to obtain CFU mL^{-1}.

Infiltrations were conducted at the 4-leaf stage using 1 cc of inoculum administered with a needleless syringe. One leaf per plant received two to four infiltration sites spaced 1 cm apart, resulting in approximately 18 infiltrations per cultivar x

isolate x replicate. The petiole of each inoculated leaf was marked with a red felt-tipped marker. The growth chamber was adjusted to maintain a relative humidity at or greater than 85% and temperature of 25 + 2 °C for 96 hours following infiltrations. Bacterial leaf spot severity was assessed at 7 and 14 days after infiltration (DAI) using a 0-4 scale in which 0 = no visible symptoms, 1 = slight chlorosis, 2 = moderate chlorosis or bleaching, 3 = slight necrosis, 4 = moderate to severe necrosis or cell death. Severity scores were converted into a quantitative disease severity index (DSI) ranging from 0 to 100. To calculate DSI, the number of infiltration sites assigned to each severity rating (0-4) was multiplied by its corresponding rating value, and these products were summed and divided by the maximum possible disease score (i.e., total number of sites × 4). This proportion was then multiplied by 100 to produce a standardized DSI value. A DSI of 100 indicates that all infiltration sites exhibited severe necrosis (i.e., rating = 4).

A combined statistical analysis was performed in R (v 4.3.1, R Core Team 2023) to elucidate treatment interactions and account for variability between individual assays. The package agricolae (v 1.3-7; de Mendiburu 2023) was used to perform a mixed model ANOVA that reflected the split-plot trial design using the sp.plot argument. Main plots (sugar beet cultivars) and subplots (bacterial isolates) were treated as fixed effects. Replication within assay was assigned as the random effect and the main-plot error term was derived from the replication*main plot interaction in the combined analyses. Mean comparisons were conducted according to the Least Significant Difference test using the LSD.test argument at a 0.05 level of significance using the respective error terms for main plots, subplots, and interactions.

On 14 DAI, symptomatic leaf tissue was excised, surface-sterilized in 0.5% NaOCl for 1 m, rinsed thrice with SDW, and homogenized in 0.05M potassium phosphate buffer within 2 mL microcentrifuge tubes containing five 3 mm-glass beads using a FastPrep-24 homogenizer (MP Biomedicals). After incubation at room temperature for 10 m, the suspension was diluted 1:10 in SDW and streaked onto NBY agar amended with cycloheximide (750 mg L^{-1}). Colony morphology was compared to original isolates to fulfill Koch's postulates.

Whole genome sequencing. Cultures taken from storage were streaked onto NBY agar and incubated for 48 hours at 28°C. Single-colony cultures were grown in nutrient broth in 15 mL sterile conical tubes at 28°C on a shaker overnight prior to DNA extraction. Fresh cells were pelleted by centrifugation at 1,000 x *g* for 1 m, the supernatant was removed, and the pellet was resuspended in 100 µL cold phosphate-buffered saline (PBS). High molecular weight gDNA was isolated using the Monarch® Spin gDNA Extraction Kit (New England Biolabs) following the manufacturer's protocol. The concentration of gDNA was evaluated using Qubit 3.0 fluorometer using the high sensitivity assay kit, gDNA quality was assessed with a NanoDrop spectrophotometer, and gDNA integrity was evaluated by loading 60 ng of gDNA on 0.8% agarose gel.

High-quality gDNA was used as input for library preparation with the Oxford Nanopore Rapid PCR Barcoding Kit 24 V14 (SQK-RPB114.24) following the manufacturer's protocol. For each sample, 3 to 5 ng of gDNA was used as starting material for the barcoding reaction. Library preparation, PCR amplification, and clean-up steps were performed according to kit instructions, using the recommended reagent volumes and cycling conditions. All barcoded samples were pooled in equimolar ratios to a combined final concentration of 300 fmol (~600 ng) into a single 1.5 mL tube. The pooled libraries were cleaned using AMPure XP following the kit instructions and responded in 15 uL of elution buffer. Approximately 75 ng of the final pooled libraries were loaded onto an Oxford Nanopore MinION Mk1D device equipped with an R10.4.1 flow cell. Sequencing was performed for 24 hours, after which the flow cell was washed using the Flow Cell Wash Kit according to the manufacturer's protocol. The same pooled libraries were then reloaded, and sequencing was continued for an additional 24 hours.

Raw POD5 files generated by the MinKNOW software were transferred to the Minnesota Supercomputing Institute (MSI) high-performance computing (HPC) system for downstream analysis. Reads were basecalled and demultiplexed using the wf-basecalling workflow (EPI2ME), which produced barcoded FASTQ files for each sample. Demultiplexed reads were then processed using the wf-bacterial-genomes workflow (EPI2ME) to generate genome assemblies and annotations. Assembly was performed with Flye, and consensus polishing was conducted using Medaka. The workflow produced barcoded FASTA assemblies and corresponding GFF annotation files for each sample, as well as antimicrobial resistance predictions. Assembly quality metrics were evaluated using QUAST, which provided summary statistics including N50, total assembly size, number of contigs, and GC content.

RESULTS AND DISCUSSION

Preliminary phylogenetics. A total of 34 bacterial isolates were collected from 14 leaf samples exhibiting BLS-like symptoms in the Red River Valley of Minnesota and southern Minnesota in 2024 (Table 1). Sample submissions spanned multiple counties and townships, indicating that BLS-like symptoms were observed broadly across the region during the

2024 growing season. In certain instances, anecdotal evidence suggests submissions coincided with periods following high wind conditions that had the potential to create leaf wounds, which are conducive to bacterial colonization.

Initial taxonomic identification using the *16S-23S* rRNA intergenic region revealed that field samples contained a distinct *Pseudomonas*-associated clade (clade I), Xanthomonas-associated clade (clade II) as well as a separate *Enterobacterales*-associated cluster (clade III) (Fig. 2).
In clade Ia, a substantial number of isolates clustered with *Pseudomonas putida*, *P. japonica*, and *P. monteilii*. This group corresponds to the *P. putida* lineage, which is phylogenetically distant from the *P. syringae* complex and is composed primarily of environmental or plant-associated epiphytes rather than aggressive foliar pathogens. Clade Ib contained a single isolate that grouped with *Pseudomonas syringae* and *P. syringae pv. aptata*, the historically recognized causal agent of bacterial leaf spot in sugar beet. In clade Ic, *Pseudomonadaceae* lineage consisted of isolates clustering with the former "straminea" group, recently reassigned to the genus *Phytopseudomonas* (Rudra & Gupta 2024) were clustered. Species in this group are generally environmental pseudomonads and are considered weakly or non-pathogenic in plants. In addition to these *Pseudomonas*-associated lineages, a large number of isolates formed a clearly separated clade (clade III) belonging to the *Enterobacterales*, including sequences related to *Pantoea agglomerans*, *Kosakonia cowanii*, *Enterobacter* spp., and *Lelliottia* spp. Members of these genera are common wound-associated colonizers, epiphytes, and opportunistic endophytes, and range ecologically from beneficial symbionts to opportunistic plant pathogens under stress or injury. Their presence suggests a diverse, wound-associated microbiome within the sampled BLS-like lesions. One isolate clustered with *Xanthomonas sacchari*, a species reported primarily as a sugarcane pathogen in clade II; however, little is known about its pathogenicity or host range outside sugarcane (Mielnichuk et al. 2021).

Analysis of BLAST results of the *gyrB* amplicons showed that, in addition to the single isolate (24_26_2) grouped with *P. syringae* pv. *aptata* in the *16S-23S* phylogeny, three additional isolates (24_49_3, 24_CR+_3, 24_CR+_5) displayed high identity (99.7–100%) to *P. syringae pv. aptata* (KM282305.1). For most other isolates, *gyrB* classification was broadly consistent with their placement in the *16S-23S* phylogeny. In contrast, the *rpoD* marker provided limited taxonomic resolution but consistently amplified only *Pseudomonas* DNA, with no amplification from most *Enterobacterales* isolates. This pattern indicates that the *rpoD* primers used here are highly *Pseudomonas*-specific. Moreover, in certain instances, this resulted in the amplification of *Pseudomonas* sequences even when the cultured isolate belonged to an unrelated genus. Such primer bias highlights an important limitation of single-locus PCR diagnostics in polymicrobial field samples.

Pathogenicity assays. Symptoms first developed approximately 3 DAI, with no rapid necrosis or water-soaking typical of a Type III secretion system (T3SS)–mediated hypersensitive response. Ratings were conducted on 7 and 14 DAI. By 14 DAI, older leaves began to senesce, indicating that plants were becoming pot-bound and the assay could not be extended beyond this point. There were no significant interactions between sugar beet cultivar and bacterial isolate for DSI or incidence at either evaluation date (Table 2). Similarly, no significant differences were detected among the three sugar beet cultivars at 7 DAI, with DSI values and incidence ranging from 18.3 to 20.1 and 50% to 51%, respectively. Non-significant differences among sugar beet cultivars persisted, with DSI values ranging from 28.4 to 30.7, and incidence was 68% at14 DAI. The lack of differences indicated that cultivar response did not influence disease development under the infiltration conditions used in this study.

In contrast, there were highly significant ($P < 0.0001$) differences among bacterial isolates for both DSI and incidence at 7 and 14 DAI. The mock control exhibited slight discoloration and mild chlorosis, consistent with mechanical damage from infiltration, but its DSI did not differ significantly from the nontreated control at either rating date. Across isolates, DSI values ranged from 8.3 to 33.4 at 7 DAI, with incidence ranging from 30% to 76%. By 14 DAI, disease severity increased for nearly all isolates, with DSI values ranging from 16.9 to 44.4 and incidence from 49% to 91%. Several isolates (24_43_2, 24_CR_1, 24_CR_3, and 24_46_1) consistently produced the highest DSI values at both rating dates, whereas others induced minimal symptom development (e.g., 24_35_5 and 24_35_2).

The delay in initial symptom development, coupled with the gradual onset of chlorosis and localized necrosis, suggests that most isolates caused symptoms primarily through wound colonization and opportunistic growth, rather than through delivery of T3SS effector proteins into host cells. The ability of most isolates to induce mild to moderate chlorosis after syringe infiltration is consistent with previous reports indicating necrosis can occur when bypassing natural infection barriers. The pathogenicity results therefore support the conclusion that a diverse wound-associated microbiome was present in BLS-like lesions.

Whole genome sequencing. Long-read sequencing of the 20 bacterial isolates generated high-coverage datasets with median read qualities ranging from Q25.92 to Q26.52 and median read lengths between 2.19 and 4.65 kb. Total sequencing yield per barcode ranged from 51 Mb to 1240 Mb, with a mean of 910 Mb, providing sufficient depth for complete or near-

complete genome assembly for all isolates. Coverage across assemblies ranged from 58X to 319X, well above the minimum threshold required for reliable consensus polishing. Genome assembly metrics varied among isolates, reflecting differences in genome size and genomic complexity. Assemblies ranged from 0.75 Mb to 5.51 Mb, with most isolates producing genome sizes consistent with *Enterobacterales* or *Pseudomonadaceae*. The number of contigs per assembly ranged from 3 to 193, with N50 values ranging from 11.7 kb to 4.8 Mb, indicating high assembly contiguity for most isolates. GC content ranged from 47.3% to 61.4%, consistent with the diversity of bacterial lineages recovered. Several isolates carried predicted antimicrobial resistance genes, including fosA2, OqxA/OqxB efflux pump components, blaERP-1, blaRAHN-2, and blaACT-12. These genes are commonly observed in environmental *Enterobacterales* and may reflect the ecological backgrounds of the isolates. Across nearly all samples, assembly quality was robust, had high coverage, and large N50 values, providing a strong foundation for downstream taxonomic and comparative genomic analyses.

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Table 1. Leaf samples with Bacterial Leaf Spot (BLS)-like symptoms submitted to the Sugar Beet Plant Pathology Lab in 2024.

Sample #	Date Sampled	State	County	Township
24_23	7/28/2024	MN	Swift	Fairfield
24_24	7/28/2024	MN	Swift	Tara
24_25	7/28/2024	MN	Stevens	Moore
24_26	7/28/2024	MN	Swift	Fairfield
24_27	7/31/2024	MN	Norman	Halstad
24_28	8/1/2024	MN	Chippewa	Rheiderland
24_35	8/5/2024	MN	Mahnomen	Popple Grove
24_43	8/6/2024	MN	Renville	Osceola
24_CR	8/19/2024	MN	Polk	Lowell
24_45	8/22/2024	MN	NA[z]	NA[z]
24_46	8/22/2024	MN	Pope	Glenwood
24_47	8/22/2024	MN	NA[z]	NA[z]
24_48	8/22/2024	MN	Pope	Bangor
24_49	8/22/2024	MN	Pope	Bangor

NA: not applicable as information was not provided on the field sample sheet.

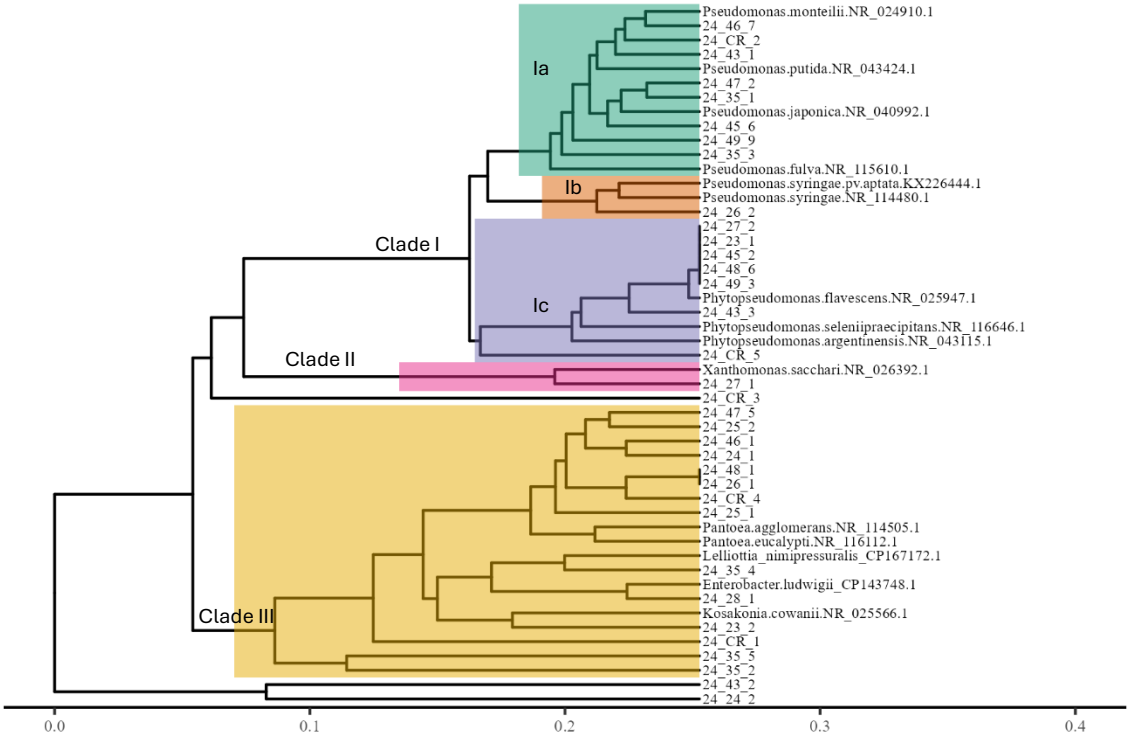

Fig 1. Preliminary phylogenetic analysis based on the *16S-23S* ribosomal RNA intergenic region.

Fig 1. Bacterial Leaf Spot (BLS)-like symptoms of field samples received in 2024 (A) and infiltration technique conducted for growth chamber pathogenicity assays (B).

Table 2. Severity and incidence of Bacterial Leaf Spot (BLS)-like symptoms on three sugar beet cultivars across 20 bacterial isolates collected from leaf samples in 2024.

Treatment	No. of infiltrations [v]	7 days after infiltration		14 days after infiltration	
		Disease severity index (0-100) [w,x]	Incidence (%) [x,y]	Disease severity index (0-100) [w,x]	Incidence (%) [x,y]
Sugar beet cultivar (main plot)					
Betaseed 8018	1641	20.1	50	29.7	68
Crystal 260	1776	18.3	50	30.7	68
Crystal 912	1737	18.5	51	28.4	68
P-value	NA	0.5069	0.9223	0.5124	0.9910
Bacterial isolate [z] (sub-plot)					
24_43_2	330	33.4 [a]	66 [a-d]	44.4 [a]	85 [a-c]
24_CR_1	310	27.2 [a-d]	64 [a-d]	43.9 [a]	85 [a-c]
24_CR_3	324	27.7 [a-c]	69 [a-c]	43.8 [a]	90 [ab]
24_46_1	316	30.0 [ab]	76 [a]	43.1 [ab]	89 [ab]
24_48_6	298	21.1 [c-h]	56 [b-e]	42.7 [ab]	87 [a-c]
24_25_2	296	26.4 [a-e]	72 [ab]	41.2 [a-c]	91 [a]
24_47_2	322	25.4 [b-f]	66 [a-d]	41.0 [a-c]	89 [ab]
24_45_6	324	23.5 [b-g]	55 [c-e]	35.2 [b-d]	83 [b-d]
24_CR_5	312	22.8 [b-h]	62 [b-d]	34.4 [cd]	85 [a-c]
24_43_3	327	16.2 [g-i]	46 [e-g]	32.3 [de]	76 [d-f]
24_35_3	143	23.2 [b-h]	60 [b-e]	30.4 [d-f]	73 [e-g]
24_24_1	141	21.6 [b-h]	58 [b-e]	30.2 [d-f]	78 [c-f]
24_35_1	160	25.0 [b-g]	74 [ab]	29.2 [d-g]	79 [c-f]
24_43_1	144	16.9 [f-i]	50 [d-f]	28.9 [d-g]	81 [b-e]
24_49_1	176	17.6 [e-i]	52 [d-f]	28.0 [d-h]	64 [g]
24_35_4	140	18.3 [d-i]	65 [a-d]	26.0 [d-h]	71 [e-g]
24_28_2	152	18.4 [c-i]	54 [c-e]	24.6 [e-h]	71 [e-g]
24_23_2	138	12.5 [h-i]	45 [e-g]	21.9 [f-h]	69 [fg]
24_35_2	129	8.4 [ij]	34 [fg]	18.3 [gh]	63 [g]
24_35_5	148	8.3 [ij]	30 [g]	16.9 [h]	49 [h]
Mock Control	524	1.7 [j]	6 [h]	3.5 [i]	14 [i]
Nontreated Control	NA	0.0 [j]	0 [h]	0.0 [i]	0 [j]
P- value	NA	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
Cultivar x Isolate Interactions					
P- value	NA	0.5229	0.3053	0.4345	0.2507

[v] The total number of infiltrations across one or two assays; the 10 most virulent isolates were re-evaluated.
[w] Disease severity index (DSI) was calculated by multiplying the number of infiltration sites in each severity category (0–4) by the category value, summing these products, dividing by the maximum possible score, and multiplying by 100 to standardize values from 0 to 100.
[x] Means within a column followed by a common letter are not significantly different according to the Least Significant Difference test at the 0.05 significance level.
[y] Incidence represents the percentage of infiltration sites exhibiting visible symptoms.
[z] The three-part isolate identifier corresponds to sampling year (24 = 2024), field sample number, and isolate number recovered from that sample.

EVALUATION OF FUNGICIDE SPRAY PROGRAMS TO MANAGE CERCOSPORA LEAF SPOT IN A CR+ SUGARBEET VARIETY, 2025

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INTRODUCTION

Cercospora leaf spot (CLS), caused by *Cercospora beticola*, continues to be a major foliar disease of sugarbeet in Minnesota and North Dakota and can cause substantial losses when weather conditions favor infection (Jones and Windels 1991). Although seedborne inoculum may contribute to early-season pathogen presence (Spanner et al. 2022) and reflects underlying genetic diversity in regional populations (Knight et al. 2018), infected residue from previous sugarbeet crops remains the primary inoculum source, with airborne conidia detectable as early as May (Secor et al. 2022; Secor and Rivera 2024). Symptoms of CLS generally appear from late June into early July as canopies close; however, recent field studies have detected *C. beticola* DNA in asymptomatic foliage weeks before visible symptoms develop, indicating that most infections likely occur throughout June (Bloomquist et al. 2021; Secor et al. 2022; Wyatt 2024). Rapid disease escalation is associated with warm, humid periods following rainfall (Tedford et al. 2018), whereas drought slows progression.

This evolving understanding of CLS epidemiology underscores the importance of well-timed, effective fungicide programs to slow disease development and protect yield and sugar quality. Recommended programs include using full labeled rates, tank-mixing with multiple modes of action, and rotation among modes of action throughout the season. Initiation of fungicide application prior to onset of visible symptom remains critical. While highly tolerant "CR+" varieties introduced in 2021 have shown delayed infection and reduced severity compared with moderately susceptible varieties in previous years (Bhuiyan et al. 2023; Bhandari et al. 2023), local *C. beticola* populations are rapidly adapting to these varieties and making them less reliable in the absence of a standard fungicide spray program. Field research demonstrates that they still require multiple, timely fungicide applications to avoid economic losses (Mettler and Bloomquist 2021, 2022, 2023; Lien et al. 2025). As the industry moves away from strategies aimed at reducing the total number of sprays or widening spray intervals, there is increased interest in understanding the risks associated with extended spray intervals and the relative benefits of initiating fungicide programs with a demethylation inhibitor (DMI) + ethylene bisdithiocarbamate (EBDC) combination versus EBDC alone. Evaluating these management questions is essential for maintaining effective CLS control amid continued pathogen pressure and changing production practices.

OBJECTIVES

The trial objective was to evaluate the efficacy of fungicide spray programs with differential application timing 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 trial was conducted at the University of Minnesota Northwest Research and Outreach Center in Crookston, MN, using a randomized complete block design with four replicates. The objective was to evaluate the efficacy of fungicide spray programs for managing CLS in a highly tolerant sugar beet variety. Fungicide programs consisted of either an early or delayed initial application of a DMI + EBDC tank-mixture, EBDC alone, or a copper fungicide alone. Subsequent applications were made at approximately 2-week intervals, with some programs including extended intervals of approximately 4, 6, or 8 weeks. Sugar beet seeds 'Crystal 260RR' were sown on 19 May in 6-row plots (35 ft long) with 22-in. row spacing and an in-row spacing of 4.5 in. Plant stands were recorded on 23 June. On 8 July, at approximately 90% row closure, all rows were inoculated with a mixture of fine talc and dried CLS-infected sugar beet leaves (1:2 w/w) applied at 4.5 lb/A. Inoculum was collected at the end of the 2024 growing season and 60% of the CLS-leaf material was collected from a "CR+" variety. Fungicides were applied to the center four rows using a tractor-mounted sprayer equipped with XR TeeJet 11002 VS nozzles calibrated to deliver 16.8 gal water/A at 90 psi. Applications occurred on 1 July, 8 July, 24 July, 7 August, 19 August, and 2 September. Cercospora leaf spot severity, expressed as percent diseased leaf area, was assessed using a modified spot-percentage scale based on Shane and Teng (1992): 1 = 0.1%, 2 = 0.35%, 3 = 0.75%, 4 = 1.5%, 5 =

2.5%, 6 = 3%, 7 = 6%, 8 = 12%, 9 = 25%, and 10 = 50%. Severity ratings were collected from five locations within the center four rows of each plot beginning 30 July and continued weekly through 22 September, for a total of six evaluations. 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. Plots were defoliated on 24 September, and the center two rows were harvested and weighed to determine root yield. Ten roots per plot were subsampled for sugar quality analysis at the American Crystal Sugar Company Quality Tare Laboratory in East Grand Forks, MN. All statistical analyses were performed in R (v. 4.3.3). A mixed-model analysis of variance was conducted using the lmerTest package (v. 3.1-3), with treatment specified as a fixed effect and replication as a random effect. Estimated marginal means were obtained and separated using emmeans (v. 1.11.0) at the $\alpha = 0.10$ significance level with no adjustment for multiple comparisons. Weather data was retrieved from the Minnesota Agricultural Weather Network, Crookston, MN Station (47.823333°, -96.620556°).

RESULTS AND DISCUSSION

A weather station located 0.63 miles north-northwest of the research plots maintained by the Northwest Research and Outreach Center, Crookston, MN (47.815374, -96.614200) recorded a total rainfall of 1.79 and 2.01 in. for April and May, which was near the 30-year average of 1.27 and 2.75 in., respectively (Supplementary Table S1). Extreme fluctuating temperatures and heavy rainfall events around the time of the initial planting contributed to soil crusting and variable emergence of sugar beet seedlings in the area. After replanting, plant populations averaged 225 plants per 100 ft of row (84.3% germination), and no significant differences among treatments were detected ($P = 0.3265$). Due to the delayed planting in 2025, canopy development was also later than normal. The trial was inoculated on July 8, coinciding with approximately 90% row closure. The first leaf spots were observed on July 16 in a nearby trial, confirming favorable conditions for disease development and frequent rainfall during late July and August created favorable conditions for CLS progression, resulting in rapid disease increase through August and September (Supplemental Fig. S1). Significant treatment differences were detected beginning 30 July and persisted through the remainder of the season (Table 1; Fig. 1). The nontreated control exhibited the greatest CLS ratings at all subsequent evaluations, exceeding the economic threshold (rating = 6, ~3% CLS severity) by 10 September. Generally, all fungicide spray programs initiated at or prior to disease onset and contained 3 or more fungicide applications maintained CLS ratings below the economic threshold throughout the trial period.

Significant treatment effects ($P < 0.0001$) were detected for overall CLS severity measured as sAUDPS (Table 2; Fig 2). The nontreated control exhibited the highest CLS severity, whereas nearly all fungicide spray programs significantly reduced disease relative to the control. Exceptions included two programs initiated with application C that incorporated a 40-day extended interval, and two programs initiated with application E, which did not significantly differ from the nontreated control. Numerically, the lowest CLS severity occurred in variations of the “standard 5-spray program,” consisting of five applications at 14-day intervals beginning with application B prior to row closure on 8 July. Within this program, substituting Manzate Pro-Stick alone, Inspire XT + Manzate Pro-Stick, or Super Tin 4L + Topsin 4.5FL for individual applications did not affect CLS severity. Introducing a single 30-day interval into the standard 5-spray sequence (e.g., omitting application D or E) led to slightly higher CLS severity (Fig. 2), although differences were not statistically significant (Table 2). Likewise, the “standard 4-spray program,” initiated with application C, at disease onset on 24 July (16 days after inoculation), resulted in greater CLS severity (Fig. 2) but did not differ statistically from the standard 5-spray program (Table 2). In contrast, spray programs consisting of three or fewer fungicide applications had significantly greater CLS severity than the standard 5-spray program, regardless of application timing. No significant treatment effects were observed for percent sugar, sugar loss to molasses (SLM), or recoverable sucrose per acre; however, root yield varied significantly among treatments (Table 2). The standard 5-spray program produced the highest root yield, consistent with its superior suppression of CLS.

Table 1. Cercospora leaf spot (CLS) 0-10 ratings associated with fungicide spray programs to manage CLS of sugarbeet in a CLS-inoculated field trial planted on 19 May 2025 and inoculated on 08 July 2025 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

#	Spray Program [v]	Longest Spray Interval (days)	Treatment(s)[w] and timing[x]	CLS ratings (0-10)[y]					
				Jul 30	Aug 13	Aug 21	Aug 28	Sept 10	Sept 22
1	Nontreated	NA	Nontreated Control	0.6	0.9	2.5	4.5	6.2	7.1
2	DMI fb Tin (AB-D-F)	30	Inspire XT **A** + Manzate Pro-Stick **AD** + Super Tin 4L **BF** + Topsin 4.5 FL **B** + Proline 480 SC **D** + Priaxor **F**	0.1	0.2	0.9	1.4	2.6	4.0
3	DMI fb EBDC (AB---F)	56	Inspire XT **A** + Manzate Pro-Stick **AB** + Super Tin 4L **F** + Priaxor **F**	0.0	0.2	1.2	2.3	3.8	5.3
4	EBDC fb DMI (AB---F)	56	Manzate Pro-Stick **AB** + Inspire XT **B** + Super Tin 4L **F** + Priaxor **F**	0.0	0.4	1.2	2.2	4.0	5.6
5	DMI fb Tin (-BCDEF)	16	Inspire XT **B** + Manzate Pro-Stick **BDE** + Super Tin 4L **CF** + Topsin 4.5FL **C** + Proline 480 SC **D** + Priaxor **F**	0.1	0.0	0.6	1.2	2.1	3.2
6	DMI fb EBDC (-BCDEF)	16	Inspire XT **B** + Manzate Pro-Stick **BCE** + Super Tin 4L **DF** + Topsin 4.5FL **D** + Proline 480 SC **E** + Priaxor **F**	0.0	0.1	0.8	1.4	2.0	2.5
7	EBDC fb DMI (-BCDEF)	16	Manzate Pro-Stick **BCE** + Inspire XT **C** + Super Tin 4L **DF** + Topsin 4.5FL **D** + Proline 480 SC **E** + Priaxor **F**	0.0	0.1	0.8	1.3	2.2	2.7
8	DMI fb Tin (-BC-EF)	26	Inspire XT **B** + Manzate Pro-Stick **BE** + Super Tin 4L **CF** + Topsin 4.5FL **C** + Proline 480 SC **E** + Priaxor **F**	0.1	0.2	0.8	1.4	2.9	3.2
9	DMI fb Tin (-BCD-F)	26	Inspire XT **B** + Manzate Pro-Stick **BD** + Super Tin 4L **CF** + Topsin 4.5FL **C** + Proline 480 SC **D** + Priaxor **F**	0.1	0.0	0.7	1.2	2.1	3.8
10	DMI fb EBDC (-BC--F)	40	Inspire XT **B** + Manzate Pro-Stick **BC** + Super Tin 4L F + Priaxor **F**	0.0	0.1	1.1	2.5	3.9	4.5
11	EBDC fb DMI (-BC--F)	40	Manzate Pro-Stick **BC** + Inspire XT **C** + Super Tin 4L **F** + Priaxor **F**	0.0	0.1	0.8	2.2	3.7	4.7
12	DMI fb Tin (--CDEF)	14	Inspire XT **C** + Manzate Pro-Stick **CE** + Super Tin 4L **DF** + Topsin 4.5FL **D** + Proline 480 SC **E** + Priaxor **F**	0.3	0.1	1.2	2.1	3.3	3.6
13	DMI fb Tin (--CD-F)	26	Inspire XT **C** + Manzate Pro-Stick **C** + Super Tin 4L **D** + Topsin 4.5FL **D** + Proline 480 SC **F** + Priaxor **F**	0.3	0.2	1.5	2.0	3.7	5.1
14	DMI fb EBDC (--CD-F)	26	Inspire XT **C** + Manzate Pro-Stick **CD** + Super Tin 4L **F** + Priaxor **F**	0.4	0.1	1.2	2.8	5.2	6.2
15	EBDC fb DMI (--CD-F)	26	Manzate Pro-Stick **CD** + Inspire XT **D** + Super Tin 4L **F** + Priaxor **F**	0.3	0.2	1.5	2.4	4.2	5.3
16	CuOCl fb DMI (--CD-F)	26	Badge SC **C** + Inspire XT **D** + Manzate Pro-Stick **D** + Super Tin 4L **F** + Priaxor **F**	0.4	0.3	1.5	2.3	4.5	6.7
17	CuSO4 fb DMI (--CD-F)	26	Cuprofix Flex **C** + Inspire XT **D** + Manzate Pro-Stick **D** + Super Tin 4L **F** + Priaxor **F**	0.5	0.3	1.1	2.8	4.8	6.0
18	DMI fb EBDC (--C--F)	40	Inspire XT **C** + Manzate Pro-Stick **C** + Super Tin 4L **F** + Priaxor **F**	0.3	0.2	1.9	3.6	5.6	6.2
19	EBDC fb DMI (--C--F)	40	Manzate Pro-Stick **C** + Super Tin 4L **F** + Priaxor **F**	0.3	0.3	2.4	4.2	5.8	7.1
20	DMI fb Tin (---DEF)	14	Inspire XT **D** + Manzate Pro-Stick **D** + Super Tin 4L **E** + Topsin 4.5FL **E** + Proline 480 SC **F** + Priaxor **F**	0.3	0.3	1.7	3.0	4.9	5.7
21	DMI (---D-F)	26	Inspire XT **D** + Manzate Pro-Stick **D** + Super Tin 4L **F** + Priaxor **F**	0.3	0.5	1.9	3.0	5.0	6.3
22	EBDC (---D-F)	26	Manzate Pro-Stick **D** + Super Tin 4L **F** + Priaxor **F**	0.3	0.3	1.8	3.1	5.0	6.6
23	DMI (----EF)	14	Inspire XT **E** + Manzate Pro-Stick **E** + Super Tin 4L **F** + Priaxor **F**	0.3	0.6	2.6	3.6	5.4	6.0
24	EBDC (----EF)	14	Manzate Pro-Stick **E** + Super Tin 4L **F** + Priaxor **F**	0.2	0.7	2.5	4.1	5.5	6.6
			LSD (α =0.10)	0.18	0.21	0.42	0.52	0.56	0.71
			P-value[z]	***	***	***	***	***	***

[v] Description of spray program; Crystal 260RR with two-year Cercospora rating of 2.6 (CR+) was used for all treatments.

[w] Treatment rates per acre are as follows: Inspire XT = 7 fl oz, Manzate Pro-Stick = 2 lb, Super Tin 4L = 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 Flex = 1.5 lb; Non-ionic surfactant (Activator 90) was used at a rate of 0.125% v/v with Proline 480 SC.

[x] Application letter code for the following dates: **A** = 01 July (7 days prior to inoculation; 70% row-closure), **B** = 08 July (day of inoculation; 90% row-closure), **C** = 24 July (disease onset; 16 days after inoculation; DAI), **D** = 07 August (30 DAI), **E** = 19 August (42 DAI), **F** = 02 September (56 DAI); any treatment beginning with application C, D, or E denotes a delayed initial application.

[y] CLS ratings, based on percent infected leaf area (i.e., 1=0.1%, 2=0.35%, 3=0.75%, 4=1.5%, 5=2.5%, 6=3%, 7=6%, 8=12% 9=25%, 10=50%), are an average of 20 ratings (5 per plot across 4 replicates).

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

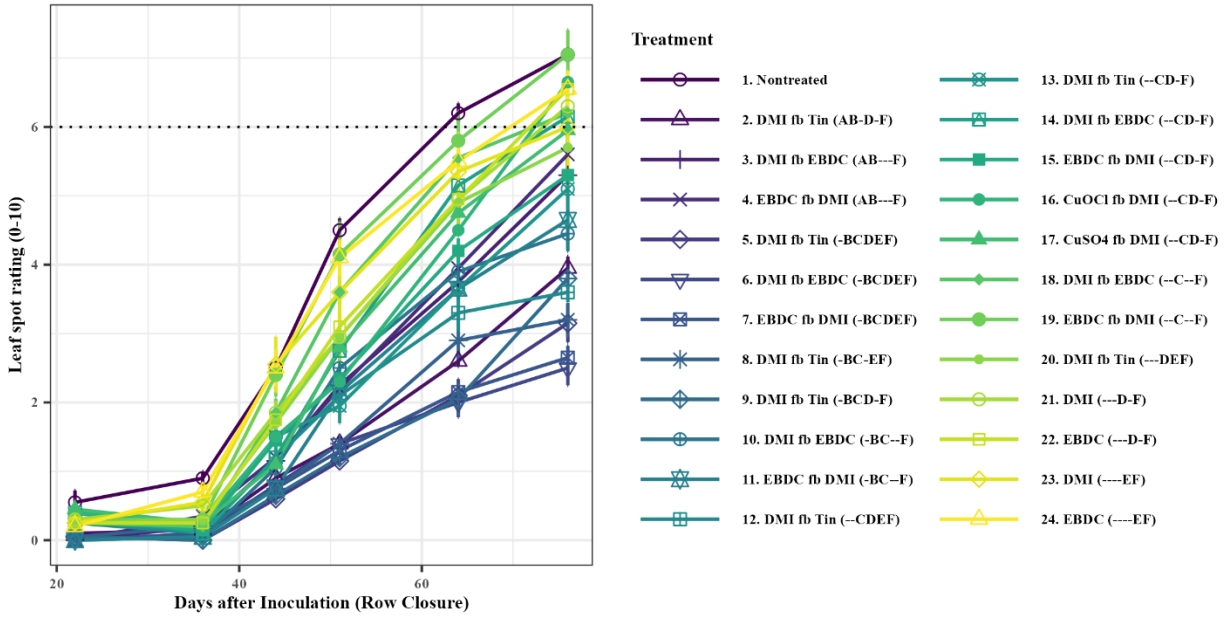

Fig. 1. Effect of foliar fungicide programs grouped by the initial application in respect to days after inoculation, equivalent to 90% row closure, in a highly CLS tolerant (CR+) variety on development of CLS in a inoculated field trial. Trial was planted on 19 May 2025 and inoculated on 08 July 2025.

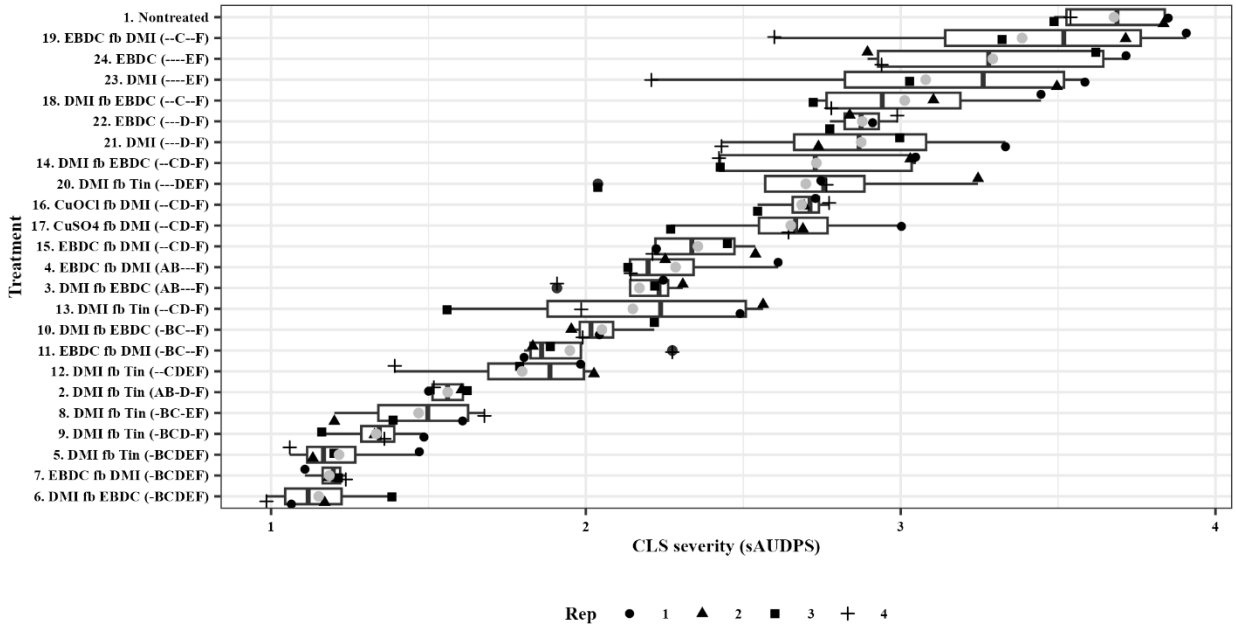

Fig. 2. Effect of foliar fungicide programs compared to the nontreated control on the severity of Cercospora leaf spot (CLS) reported as the standardized area under the disease progress stairs (sAUPDS) in a sugarbeet field trial inoculated with CLS-infested leaves in Crookston, MN. Box-whisker plots display the distribution of data for each treatment (minimum, first quartile, median, third quartile, and maximum); shapes represent each data point; gray filled dots represent treatment means.

Table 2. Effects of fungicide spray programs on CLS severity, root yield, and sucrose quality of sugarbeet in a CLS-inoculated field trial planted on 19 May 2025 and inoculated 08 July 2025 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

#	Spray Program [v]	CLS Severity (sAUDPS) [w,x]	Sugar (%)	Sugar Loss to Molasses (%)	Root Yield (tons/A)	Sucrose Yield (lbs/A)
1	Nontreated	3.68 k	15.92	1.28	22.8 ab	6720
2	DMI fb Tin (AB-D-F)	1.56 a-d	16.17	1.28	24.4 ab	7285
3	DMI fb EBDC (AB---F)	2.17 d-f	16.16	1.25	23.6 ab	7052
4	EBDC fb DMI (AB---F)	2.29 e-g	16.11	1.21	24.9 ab	7429
5	DMI fb Tin (-BCDEF) [y]	1.22 a	16.01	1.25	26.1 b	7713
6	DMI fb EBDC (-BCDEF)	1.15 a	15.78	1.24	24.8 ab	7237
7	EBDC fb DMI (-BCDEF)	1.19 a	16.31	1.25	25.7 ab	7740
8	DMI fb Tin (-BC-EF)	1.47 a-c	15.95	1.28	23.9 ab	6995
9	DMI fb Tin (-BCD-F)	1.33 ab	16.05	1.24	25.1 ab	7448
10	DMI fb EBDC (-BC--F)	2.05 c-f	15.66	1.27	23.3 ab	6735
11	EBDC fb DMI (-BC--F)	1.95 b-e	16.68	1.24	24.0 ab	7434
12	DMI fb Tin (--CDEF) [z]	1.80 a-e	16.55	1.28	23.1 ab	7062
13	DMI fb Tin (--CD-F)	2.15 c-f	15.68	1.31	24.0 ab	6907
14	DMI fb EBDC (--CD-F)	2.73 f-j	15.79	1.25	23.8 ab	6938
15	EBDC fb DMI (--CD-F)	2.36 e-h	16.80	1.25	23.5 ab	7316
16	CuOCl fb DMI (--CD-F)	2.68 f-i	16.45	1.24	24.2 ab	7356
17	$CuSO_4$ fb DMI (--CD-F)	2.65 f-i	16.16	1.26	22.0 a	6552
18	DMI fb EBDC (--C--F)	3.01 h-k	16.00	1.36	23.4 ab	6855
19	EBDC fb DMI (--C--F)	3.39 jk	16.25	1.24	24.1 ab	7234
20	DMI fb Tin (---DEF)	2.70 f-j	15.80	1.29	23.3 ab	6779
21	DMI (---D-F)	2.88 g-j	16.18	1.28	22.8 ab	6791
22	EBDC (---D-F)	2.88 g-j	16.49	1.25	22.3 a	6804
23	DMI (----EF)	3.08 i-k	16.26	1.23	23.1 ab	6939
24	EBDC (----EF)	3.29 i-k	15.90	1.27	22.3 ab	6529
	CV (%)	**33.8**	4.22	5.70	**8.27**	10.7
	LSD (α = 0.10)	**0.325**	0.668	0.079	**1.80**	682.4
	P-value	**<0.0001**	0.2905	0.6839	**0.0238**	0.1555

[v] 'Crystal 260RR' variety (CR+) with two-year mean CLS rating of 2.6 was used for all treatments; fungicides and application dates for each program are listed in Table 1.
[w] 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.
[x] The coefficient of variation (CV) was calculated as (SD/mean) × 100. Higher CV values indicate greater experimental variability
[x] Least significant difference (LSD) was calculated from mixed-model EMM pairwise comparisons.
[y] 'Standard 5-spray program' consisting of 5 applications with approximately 14-day intervals initiated prior to row closure on 08 July.
[z] 'Standard 4-spray program' consisting of 4 applications with approximately 14-day intervals initiated at disease onset.

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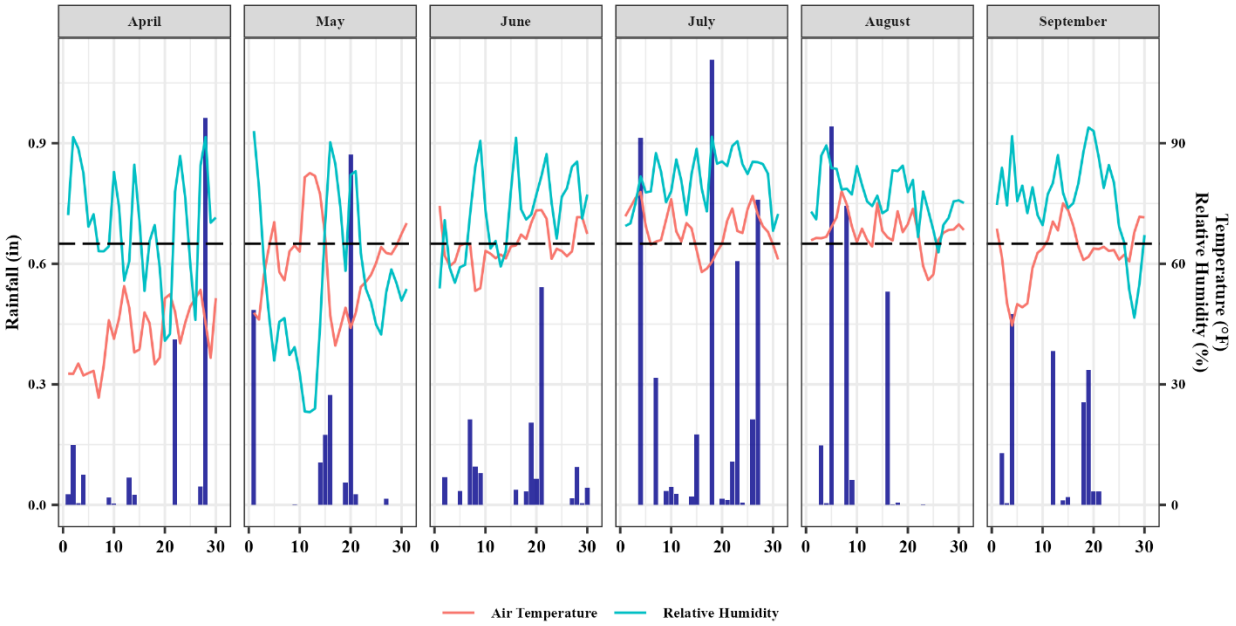
SUPPLEMENTARY WEATHER TABLE AND FIGURE

Supplementary Table S1. Weather data for the 2025 growing season compared to the normal (30-year average). Data was retrieved from the Crookston Minnesota Agricultural Weather Network station (47.823333, -96.620556), located approximately 0.63 miles north-northwest of the research plots maintained by the Northwest Research and Outreach Center (NWROC), Crookston, MN.

Month	Total Rainfall (inch)		Average Air Temperature (°F)	
	2025	Normal [z]	2025	Normal [z]
April	1.79	1.27	41.8	40.8
May	2.01	2.75	59.8	54.7
June	1.52	4.15	63.6	65.2
July	4.36	3.27	67.6	69.1
August	2.44	2.97	68.2	67.4
September	1.68	2.6	62.8	58.2
Growing Season	**13.80**	**17.01**	**60.6**	**59.2**

[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 (bars) and daily mean air temperature (red line), and daily mean relative humidity (blue line) for the 2025 growing season recorded 0.63 miles north-northwest of research plots in Crookston, MN. The dotted horizontal line represents 65°F.

EVALUATION OF SEED TREATMENTS, IN-FURROW FUNGICIDES, AND IN-FURROW BIOCONTROL AGENTS FOR MANAGEMENT OF *RHIZOCTONIA SOLANI* IN SUGARBEET, 2025

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INTRODUCTION

Over the past decade, *Rhizoctonia solani*, the causal agent of damping-off and Rhizoctonia crown and root rot (RCRR), has consistently been the most frequently diagnosed 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, 2024). Warm soils with adequate moisture strongly favor pathogen development, leading to preemergence and post-emergence damping-off that reduces early-season stands. root and crown rot later in the season contributes to stand decline, reduced root yield, and diminished sucrose quality. In storage, moderately to severely infected roots have greater sugar losses due to increased respiration, which can further impact storability of adjacent healthy roots (Campbell et al. 2013). The pathogen is presumed to be present in most agricultural soils across the region, and more than half of growers surveyed in 2023 reported fields affected by RCRR (Hakk et al. 2024). This widespread prevalence is supported by the pathogen's broad host range, including soybeans, edible beans, and corn (Windels and Brantner 2006, 2010a, 2010b), and its ability to persist for multiple years in soil as sclerotia or infected residues, with dissemination facilitated by water, soil movement, and tare soil from harvest operations.

Effective management of diseases caused by *R. solani* relies on an integrated strategy that may include rotation with non-host crops such as small grains, use of Rhizoctonia tolerant sugar beet varieties, early planting when soils are cooler, improved soil drainage, and applications of fungicides as seed treatments, in-furrow (IF) placements, or postemergence sprays (Windels et al. 2009; Chanda et al. 2016, 2017, 2019; Brantner and Chanda 2018, 2020; Lien et al. 2022, 2023, 2024). Commercial sugarbeet seed is routinely sold with fungicide seed treatments targeting *R. solani*, although the active ingredient varies among brands. Growers can also supplement protection with IF fungicides at planting, which generally provide longer soil persistence and extended early-season activity relative to seed-applied products. Alongside these chemical control options, interest in biological control agents has increased due to their potential environmental benefits and compatibility with integrated disease management programs.

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 5.6% using a moderately susceptible sugar beet variety ('Crystal 793RR'; Brantner et al. 2025). Field plots were fertilized for optimal yield and quality according to University of Minnesota Extension guidelines in the fall of 2024. Treatments were arranged in a randomized complete block design with four replicates. Seed treatments were applied by Germains Seed Technology, Fargo, ND. All seeds were commercially treated with Allegiance, Thiram, and Tachigaren (45 g/unit) as base treatment. In-furrow fungicides and biocontrol agents (Table 1) treatments were applied down the drip tube in 6 gallons of water/A to seeds with base treatment only. The nontreated control received base treatment only. Prior to planting, soil was infested with *R. solani* AG 2-2–infested whole barley (a mixture of two AG 2-2 IIIB and two AG 2-2 IV isolates) at 44.6 lb/A (≈50 kg/ha). Infested barley was hand-broadcast across plots and incorporated with an 11-ft Rau seedbed finisher. The trial was sown on 07 May in six-row plots (22-inch row spacing, 30-ft rows) at a 4.5-inch seed spacing.

Counter 20G was applied with a modified in-furrow application at 7.5 lb/A followed by a postemergence application of Mustang Maxx (4 fl oz/A) on 04 June (10 gal/A, 30 psi, TeeJet 8002 nozzles) for sugarbeet root maggot management;

approximate fly counts were 33 and 110 flies per sticky-stake trap on 03 June and 05 June, respectively. Preplant ethofumesate (6 pt/A) was incorporated using a front-mounted spray boom on a Rau seedbed finisher, followed by a combination of RoundUp PowerMax 3 (28 fl oz/A) and Stinger HL (3 fl oz/A) on 04 June, and an application of Sequence (2.5 pt/A) on 27 June for weed control. Cercospora leaf spot was managed using fungicide program consisting of Inspire XT + Manzate Pro-Stick (7 fl oz + 2 lb/A) on 25 July, SuperTin 4L + Topsin 4.5 FL (8 + 10 fl oz/A) on 13 August, and Proline 480 SC + Manzate Pro-Stick (5.7 fl oz + 2 lb/A) on 26 August.

Plant stands were evaluated from May 19 (12 DAP) through June 10 (34 DAP) by counting healthy plants in the center two rows of each plot. On September 16, plots were defoliated, and the center two rows of each plot were harvested mechanically and weighed for root yield. Immediately after harvest, ten representative roots per plot were submitted to the American Crystal Sugar Company Quality Tare Laboratory (East Grand Forks, MN) for sugar quality analysis. Twenty roots per plot were arbitrarily selected and rated for Rhizoctonia crown and root rot (RCRR) severity based on a 0–10 scale with 10% increments (0 = 0%, 5 = 41–50%, 10 = 91–100%), and the remaining harvested roots were counted. Ratings were midpoint-transformed to percent severity for statistical analysis. Statistical analysis was conducted in R (v. 4.3.3; R Core Team 2025). A mixed-model analysis of variance was performed using the lmerTest package (v. 3.1-3), with treatments defined as the fixed factor and replication as the random factor. Treatment means were separated at the 0.10 significance level using emmeans (v. 1.11.1) with no adjustments. A similar model was used to compare application types (seed treatments, in-furrow fungicides, and in-furrow biocontrol agents), with application type defined as the fixed factor.

RESULTS AND DISCUSSION

Total rainfall in April and May measured 1.79 and 2.01 inches, respectively, which was similar to the 30-year averages and created conditions suitable for moderate early-season *Rhizoctonia* pressure. Plant stand counts taken on 19 May (12 DAP) did not differ significantly among treatments, although Bexfond, Serenade ASO, and Headline SC had the highest numerical stands (Table 1). When plant stands were analyzed by application type, a significant difference was detected in which the in-furrow biocontrol treatments resulted in faster plant emergence than the in-furrow fungicides and seed treatments but were not different from the nontreated control (Table 1; Fig. 1). By 10 June (34 DAP), seed treatments maintained the highest plant populations and were significantly greater than in-furrow fungicides but did not differ from the in-furrow biocontrol agents or the nontreated control (Table 1; Fig. 1).

At harvest, the number of harvested roots differed among treatments. Systiva XS and Bexfond had a greater number of harvested roots than Propulse, while the remaining treatments did not differ significantly (Table 2). No significant treatment effects ($P > 0.10$) were observed for RCRR severity or incidence, percent sugar, sugar loss to molasses (SLM), root yield, or recoverable sucrose (Table 2). When analyzed by application type, only RCRR severity and percent sugar differed significantly (Table 2). Seed treatments and in-furrow fungicides resulted in the lowest RCRR severity, while seed treatments produced the highest percent sugar (Table 2). Overall, IF biological treatments improved early emergence compared to IF fungicide treatments, which carried some risk of reduced stands when planting conditions were not optimal. Even with continued rainfall in July producing moderate RCRR pressure, treatments performed similarly in terms of reducing disease severity.

ACKNOWLEDGEMENTS

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Table 1. Effects of at-planting fungicide treatments on emergence and stand establishment in a *Rhizoctonia*-infested field trial planted on 07 May 2025 at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

Treatment and (rate) [t]	Plants per 100-ft row [u]					
	May 19 (12 DAP) [v,w]	May 23 (16 DAP)	May 28 (21 DAP)	June 2 (26 DAP)	June 6 (30 DAP)	June 10 (34 DAP)
Nontreated Control	98	122	188 bc	195 bc	194 abc	198 abc
Kabina ST (14 g) [x]	99	120	188 bc	200 c	202 c	208 c
Systiva XS (5 g) [x]	104	129	193 c	203 c	205 c	209 c
Vibrance (1.5 g) [x]	101	119	183 bc	194 bc	196 abc	198 abc
Zeltera (0.1 g) [x]	98	122	190 bc	198 bc	200 bc	203 bc
Quadris (9.5 fl oz) [y]	109	130	178 abc	183 abc	184 abc	190 abc
Elatus WG (7.1 oz) [y]	98	119	174 abc	179 abc	181 abc	183 abc
AZteroid FC3.3 (5.7 fl oz) [y]	107	125	192 bc	204 c	202 c	204 bc
Headline SC (9 fl oz) [y]	120	142	186 bc	198 bc	197 abc	202 bc
Priaxor (6.7 fl oz) [y]	101	122	183 bc	195 bc	196 abc	202 bc
Proline 480 SC (5.7 fl oz) [y]	85	112	160 ab	168 ab	172 ab	176 ab
Propulse (13.6 fl oz) [y]	88	103	149 a	162 a	167 a	171 a
Zironar (12 fl oz) [z]	102	132	170 abc	179 abc	178 abc	181 abc
Bexfond (14 fl oz) [z]	128	145	194 c	202 c	201 bc	207 c
Serenade ASO (128 fl oz) [z]	127	147	195 c	198 bc	199 bc	205 bc
Howler EVO (40 fl oz) [z]	111	127	195 c	204 c	205 c	208 c
P-value	0.1188	0.2781	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Analysis by Application Type						
Nontreated Control	98 ab	122 ab	188 ab	195 ab	194 ab	198 ab
Fungicide Seed Treatments	101 a	122 ab	188 b	199 b	201 b	204 b
In-furrow Fungicide Treatments	101 a	122 a	175 a	184 a	186 a	190 a
In-furrow Biocontrol Agents	117 b	138 b	189 b	196 b	196 ab	200 ab
P-value	**0.0027**	**0.0991**	**0.0096**	**0.0110**	**0.0075**	**0.0100**

[t] Treatments were applied as a seed treatment or in-furrow application; the active ingredient and FRAC group of each product is as follows: Kabina 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), Serenade ASO is *B. subtilis* QST713 (BM02), Howler EVO is *Pseudomonas chlororaphis* AFS009 (BM02).

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

[v] 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.

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

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

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

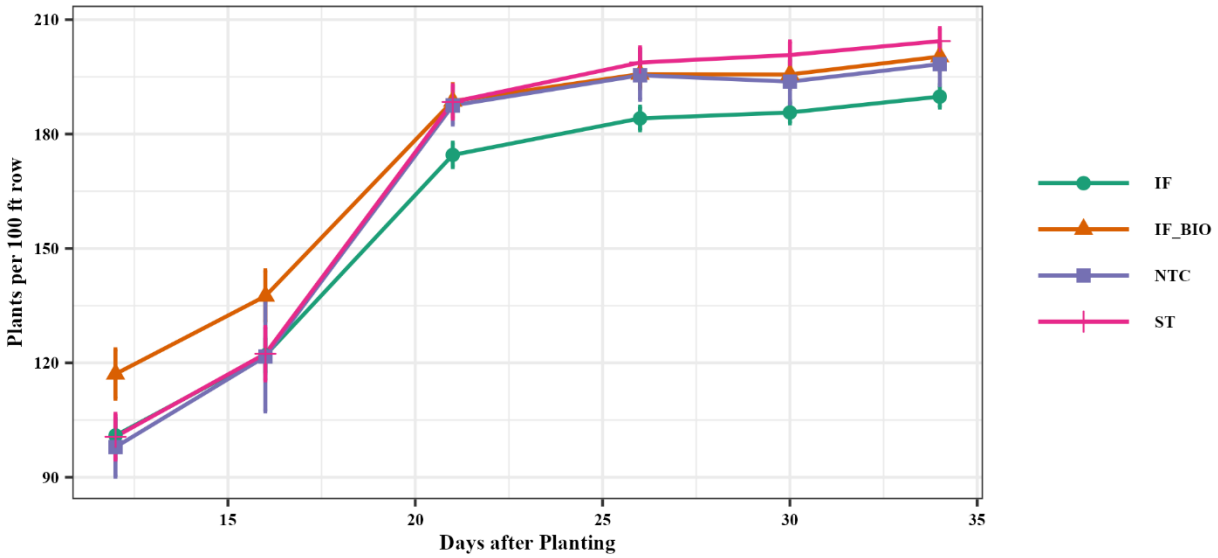

Fig. 1. Emergence and stand establishment of seed treatments (ST), in-furrow fungicides (IF), and in-furrow biocontrol agents (IF_BIO) compared to the nontreated control (NTC) in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2 in Crookston, MN planted on 07 May 2025.

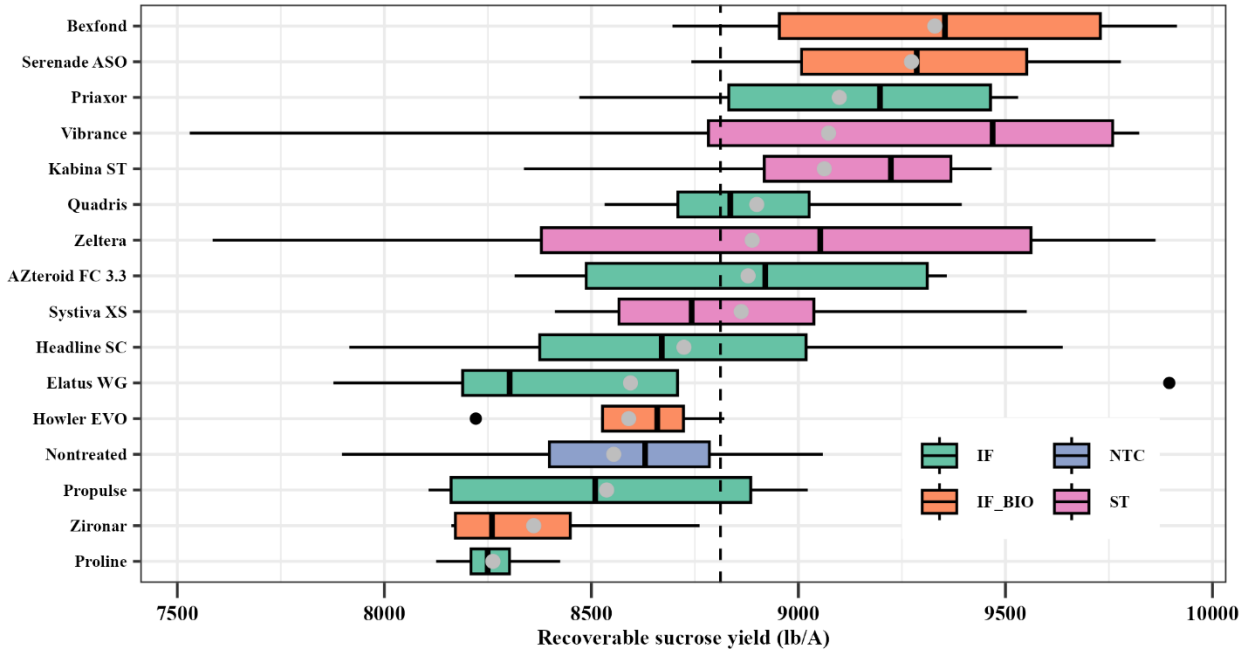

Fig. 2. Effect of at-planting treatments applied as either a seed treatment (ST), and in-furrow fungicide (IF), or in-furrow biocontrol agents (IF_BIO) on recoverable sucrose (lbs/A) in sugarbeet compared to the nontreated control (NTC) in a field trial infested with *Rhizoctonia solani* AG 2-2 in Crookston, MN. Boxplots display the distribution of data for each treatment based (minimum, first quartile, median, third quartile, and maximum); filled black dots represent outliers; filled gray dots represent treatment means. The dashed horizontal line represents the mean of all treatments in this trial.

Table 2. 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 07 May 2025.

Treatment and (rate)[p]	Harvested Roots[q]	Plant Loss (%)[r]	RCRR Severity (%)[s,t]	RCRR Incidence (%)[u]	Sugar (%)	SLM (%)[v]	Root Yield (tons/A)	Sucrose Yield (lbs/A)[w]
Nontreated Control	161 ab	18.9	9.1	27.5	17.28	1.43	27.0	8554
Kabina ST (14 g) [x]	168 ab	19.0	4.6	16.3	17.94	1.31	27.3	9063
Systiva XS (5 g) [x]	171 b	18.2	6.3	25.0	17.32	1.37	27.8	8862
Vibrance (1.5 g) [x]	168 ab	15.4	6.9	22.5	17.50	1.37	28.1	9073
Zeltera (0.1 g) [x]	163 ab	19.9	5.2	21.3	17.58	1.41	27.4	8888
Quadris (9.5 fl oz) [y]	155 ab	18.2	7.9	33.8	17.03	1.27	28.3	8899
Elatus WG (7.1 oz) [y]	160 ab	12.9	6.5	25.0	17.30	1.35	26.9	8594
AZteroid FC3.3 (5.7 fl oz) [y]	164 ab	20.4	5.0	27.5	17.24	1.34	27.9	8878
Headline SC (9 fl oz) [y]	165 ab	18.4	8.7	33.8	17.05	1.44	27.9	8724
Priaxor (6.7 fl oz) [y]	170 ab	15.9	7.3	26.3	17.20	1.34	28.7	9099
Proline 480 SC (5.7 fl oz) [y]	152 ab	14.0	4.7	17.5	17.25	1.40	26.1	8262
Propulse (13.6 fl oz) [y]	139 a	19.0	5.1	23.8	17.25	1.36	26.9	8537
Zironar (12 fl oz) [z]	149 ab	17.5	11.3	31.3	17.24	1.39	26.4	8361
Bexfond (14 fl oz) [z]	177 b	14.5	6.5	22.5	17.39	1.33	29.0	9329
Serenade ASO (128 fl oz) [z]	166 ab	19.2	8.8	32.5	17.54	1.30	28.6	9273
Howler EVO (40 fl oz) [z]	170 ab	18.4	10.9	37.5	16.87	1.30	27.6	8590
P-value	**0.0301**	0.2190	0.2783	0.2879	0.0918	0.4781	0.4232	0.3366
Analysis by Application Type								
Nontreated Control	161	18.9	9.1 ab	27.5	17.28 ab	1.43	27.0	8554
Fungicide Seed Treatments	168	18.1	5.7 a	21.3	17.59 b	1.36	27.7	8971
In-furrow Fungicide Treatments	158	17.0	6.5 a	26.8	17.19 a	1.36	27.5	8713
In-furrow Biocontrol Agents	166	17.4	9.4 b	30.9	17.26 ab	1.33	27.9	8888
P-value	0.1518	0.7225	**0.0239**	0.1040	**0.0193**	0.3129	0.7629	0.4059

[p] Treatments were applied as a seed treatment or in-furrow application; the active ingredient and FRAC group of each product is as follows: Kabina 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), Serenade ASO is *B. subtilis* QST713 (BM02), Howler EVO is *Pseudomonas chlororaphis* AFS009 (BM02).

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

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

[s] 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.

[t] 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.

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

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

[x] Fungicide seed treatments; rates are per unit of seed (100,000 seeds).

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

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

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EVALUATION OF POSTEMERGENCE FUNGICIDES AND APPLICATION METHOD ON SUGAR BEET FOR CONTROL OF RHIZOCTONIA CROWN AND ROOT ROT, 2025

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Rhizoctonia crown and root rot (RCRR), caused by *Rhizoctonia solani* AG 2-2, is a persistent and economically important root disease of sugarbeet in Minnesota and North Dakota. Protection from early-season damping-off caused by *R. solani* is typically achieved through seed treatments and in-furrow fungicides; however, the efficacy of these at-planting approaches generally diminishes within the first few weeks after emergence. Because RCRR can continue to develop throughout the season, especially when warm, moist soils favor pathogen activity, plants remain vulnerable to stand loss, root rot, and declines in sucrose quality well beyond the period covered by seed or in-furrow treatments. Although planting varieties with tolerance to RCRR is an important component of disease management, varietal resistance in sugarbeet is age-dependent, and all varieties remain susceptible during the early growth stages (Liu et al. 2019). Increase in inter-row cultivation to manage herbicide resistant weeds is resulting in throwing soil into crown areas which are highly susceptible to Rhizoctonia infection.

Postemergence fungicides have therefore become an important tool for extending protection into mid-season, particularly when applications are made at the 4- to 8-leaf stage, where they have been shown to reduce RCRR severity and minimize yield loss (Windels et al. 2009; Chanda et al. 2016, 2017, 2018, 2019, 2020, 2021). Despite the number of fungicides currently labeled for postemergence management of RCRR, relatively few field studies have directly compared their efficacy under uniform disease pressure. Furthermore, it remains unclear whether fungicide performance differs between broadcast applications and narrower 7-in. banded applications, the latter of which may improve treatment precision and reduce cost but could also limit fungicide coverage. Improved understanding of these application strategies is critical for optimizing RCRR management, particularly in seasons where environmental conditions support moderate to high disease pressure.

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 study was conducted at the University of Minnesota Northwest Research and Outreach Center (NWROC) in Crookston, MN, on a Hegne–Fargo silty clay soil with 5.6% organic matter. The field received fertilizer according to University of Minnesota fertilizer guidelines in the fall of 2024 to support optimal root yield and sucrose quality. A moderately susceptible sugarbeet variety 'Crystal 793RR', with a two-year average Rhizoctonia rating of 4.1 (Brantner et al. 2025), was used. Seed was commercially treated with Allegiance, Thiram, Tachigaren (45 g a.i./unit), and Kabina (14 g a.i./unit). Plots were arranged in a randomized complete block design with four replications. Sugarbeet was planted on 07 May in six-row plots (22-in. row spacing, 30-ft length) using a Monosem NG Plus planter at a 4.5-in. seed spacing. At planting, an XLR-rate starter fertilizer (7-23-5) was applied in-furrow at 3 gal/A with a total application volume of 6 gal/A, and Counter 20G was applied at 7.5 lb/A. Mustang Maxx (4 fl oz/A) was applied on 04 June (10 gal/A, 30 psi, TeeJet 8002 nozzles) for sugarbeet root maggot management; approximate fly counts were 33 and 110 flies per sticky-stake trap on 03 June and 05 June, respectively. Preplant ethofumesate (6 pt/A) was incorporated using a front-mounted spray boom on a Rau seedbed finisher, followed by a combination of RoundUp PowerMax 3 (28 fl oz/A) and Stinger HL (3 fl oz/A) on 04 June, and an application of Sequence (2.5 pt/A) on 27 June for weed control. Cercospora leaf spot was managed using fungicide program consisting of Inspire XT + Manzate Pro-Stick (7 fl oz + 2 lb/A) on 25 July, SuperTin 4L + Topsin 4.5 FL (8 + 10 fl oz/A) on 13 August, and Proline 480 SC + Manzate Pro-Stick (5.7 fl oz + 2 lb/A) on 26 August.

Postemergence fungicide treatments for Rhizoctonia management (Table 1) were applied on 17 June at the 8-leaf stage to the center four rows of each plot. Treatments were applied either as a 7-in. band or as a full broadcast using a tractor-mounted sprayer equipped with TeeJet 8002 (band) or 11002 (broadcast) flat-fan nozzles calibrated to deliver 10 gal/A at 30 psi. Following the appropriate re-entry interval, plots were inoculated the same day (17 June) by applying 0.71 oz/row of

R. solani-infested barley directly over the crowns using a tractor-driven Gandy applicator. The inoculum consisted of autoclaved barley colonized with two isolates each of *R. solani* AG 2-2 IIIB and AG 2-2 IV. After colonization, barley was air-dried, ground using a Wiley mill, and passed through a 3-mm sieve prior to field application. Inter-row cultivation occurred on 23 June.

Plant stands were assessed on 18 June (42 days after planting) by counting living plants in the center two rows of each plot. On 12 September, plots were defoliated and the center two rows were harvested and weighed to obtain root yield. Ten representative roots per plot were submitted to the American Crystal Sugar Company Quality Tare Laboratory (East Grand Forks, MN) for sucrose quality analysis. Following harvest, twenty additional roots were arbitrarily selected from each plot and rated for RCRR severity. Remaining roots were counted to determine the number of harvested roots. Disease severity was evaluated using a 0-10 scale corresponding to 10% increments of root area affected (0 = no visible rot, 1 = 1–10%, 5 = 41–50%, 10 = 91–100%). Ratings were transformed to midpoint percentage values for statistical analysis. Statistical analyses were conducted in R (v. 4.3.3; R Core Team 2025). A mixed-model ANOVA was performed using the lmerTest package (v. 3.1-3), with treatment considered a fixed effect and replication a random effect. Estimated marginal means (EMMs) were separated at the 0.10 significance level using emmeans (v. 1.11.1), and treatment contrasts were performed to compare banded versus broadcast applications. Weather data was retrieved from the Minnesota Agricultural Weather Network, Crookston, MN Station (47.823333°, -96.620556°).

RESULTS AND DISCUSSION

A weather station located 1.72 miles north-northwest of the research plots maintained by the Northwest Research and Outreach Center, Crookston, MN (47.801785, -96.600455) recorded a total rainfall of 1.79 and 2.01 in. for April and May, which was near the 30-year average of 1.27 and 2.75 in., respectively (Supplementary Table S1). Extreme fluctuating temperatures around the time of planting and heavy rainfall events contributed to soil crusting and variable emergence of sugar beet seedlings in the area. In this trial, there was a moderately high plant population of 181 plants per 100 ft of row, equivalent to 67.8% emergence, averaged across the reported treatments in this trial on 18 June. There were no significant (P = 0.3776) differences among treatments for plant populations on 18 June (42 DAP).

Mean daily soil temperatures rose above 65°F after June 14, the temperature which is known to be conducive for *R. solani* infection, and rainfall totaling 0.84 in. shortly after fungicide application and inoculation (Supplementary Fig. S1) created conditions favorable for *R. solani* development at the trial site, resulting in moderate disease pressure. Under these conditions, significant differences in plant loss were observed among treatments, with the nontreated control showing the greatest reduction in stand (Table 1). All fungicide treatments improved plant survival relative to the nontreated control, reflecting the importance of postemergence protection once early-season seed-applied fungicides no longer provide activity. Clear treatment effects were also detected for both RCRR severity and incidence (Table 1). Every fungicide program, regardless of product or application method, significantly reduced disease compared with the nontreated control. This indicates that all evaluated fungicides provided meaningful suppression of RCRR when applied at the 6-8 leaf stage, even under moderate disease pressure.

Differences in sucrose quality traits were minimal; although percent sugar and recoverable sucrose yield did not vary significantly among treatments, there was a detectable effect on sugar loss to molasses (SLM; Table 1). AZterknot applied as a 7-in. band had the lowest SLM values, but this treatment differed statistically only from the 7-in. band applications of AZteroid FC[3.3] and Quadris. There were no significant differences ($P > 0.10$) in the number of harvested roots, percent sugar, 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 sucrose yield.

Contrast analysis comparing all 7-in. banded applications with all broadcast applications showed greater plant loss in the broadcast treatments (Table 1). However, banded and broadcast treatments both reduced RCRR severity and incidence relative to the nontreated control. Overall, the findings from this study demonstrate that postemergence fungicides applied at the 6- to 8-leaf stage can significantly reduce RCRR-related stand loss and disease severity in a moderately susceptible sugarbeet variety. While both application methods provided substantial disease suppression, 7-in. band applications performed slightly better under the conditions of this trial, suggesting a potential advantage in seasons or fields with elevated disease risk.

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)[q]	Harvested Roots[r]	Plant Loss (%)[s,t]	RCRR Severity (%)[t,u]	RCRR Incidence (%)[v]	Sugar (%)	SLM (%)[w]	Yield (tons/A)	Sucrose (lb/A)[x]
Nontreated	138	24.5 b	22.1 b	51.3 b	16.09	1.49 ab	25.9	7583
Elatus WG (7.1 oz)[y]	163	9.4 a	1.2 a	11.3 a	16.56	1.47 ab	30.2	9100
Elatus WG (7.1 oz)[z]	159	15.8 ab	1.1 a	3.8 a	16.36	1.48 ab	27.7	8243
Excalia (0.64 fl oz)[y]	157	13.4 ab	1.3 a	6.3 a	16.59	1.51 ab	26.4	7962
Excalia (2 fl oz)[z]	152	13.3 ab	0.8 a	5.0 a	16.22	1.60 ab	26.3	7694
Quadris (10 fl oz)[y]	150	12.2 a	0.9 a	8.8 a	16.95	1.47 ab	26.3	8163
Quadris (10 fl oz)[z]	149	18.7 ab	3.5 a	20.0 a	16.55	1.52 ab	26.1	7848
Quadris (14.3 fl oz)[y]	158	14.8 ab	2.0 a	11.3 a	16.92	1.61 b	26.7	8160
Quadris (14.3 fl oz)[z]	160	12.9 a	2.7 a	12.5 a	16.60	1.56 ab	27.7	8328
AZteroid FC[3.3] (9.2 fl oz)[y]	163	10.5 a	2.8 a	7.5 a	16.40	1.61 b	29.9	8809
AZteroid FC[3.3] (9.2 fl oz)[z]	154	16.3 ab	1.5 a	3.8 a	16.53	1.54 ab	28.3	8472
AZterknot (16.6 fl oz)[y]	160	13.5 ab	2.7 a	12.5 a	16.85	1.44 a	28.7	8834
AZterknot (16.6 fl oz)[z]	154	13.0 a	2.0 a	5.0 a	16.81	1.50 ab	26.8	8194
Proline 480 SC (5.7 fl oz)[y]	149	12.8 a	3.3 a	21.3 a	16.46	1.46 ab	27.5	8274
Proline 480 SC (5.7 fl oz)[z]	153	16.1 ab	4.2 a	10.0 a	16.27	1.50 ab	27.0	7994
P- value	0.2952	**0.0216**	**<0.0001**	**<0.0001**	0.3858	**0.0391**	0.4500	0.4222
Contrast analysis of 7-in. Band Treatments vs. Broadcast Treatments								
7-in. Band	157	12.4	2.0	11.3	16.68	1.51	28.0	8472
Broadcast	154	15.1	2.2	8.6	16.48	1.53	27.1	8110
P- value	0.3585	**0.0380**	0.8650	0.3911	0.1393	0.3531	0.2522	0.1090

[q] 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)

[r] Harvest roots are equal to number of roots per 100 ft of row.

[s] Plant loss percent equals 100 * (live plants per 100 ft row on 18 Jun [42 DAP] – number of harvested roots) / live plants per 100 ft row on 18 Jun [42 DAP]

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

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

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

[y] 7-inch band application.

[z] Broadcast application.

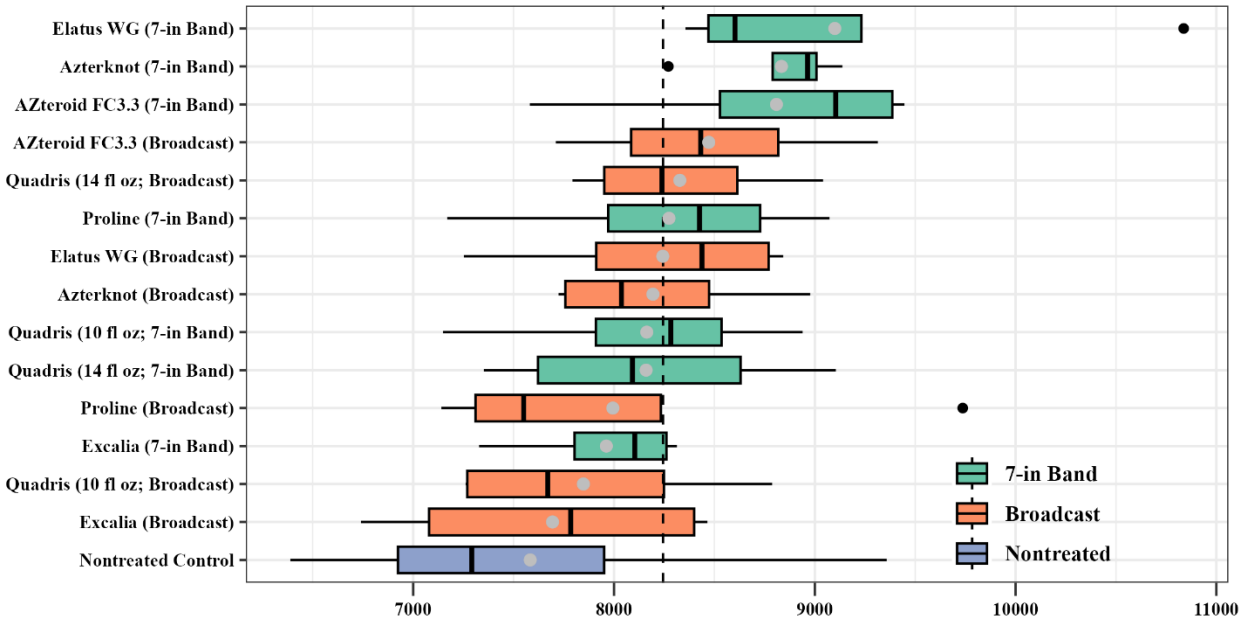

Fig. 1. Effect of postemergence fungicide treatments applied as a 7-in. band application or a broadcast application on recoverable sucrose (lbs/A) in sugarbeet compared to the nontreated control in a field trial inoculated with *Rhizoctonia solani* AG 2-2 in Crookston, MN. Boxplots display the distribution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

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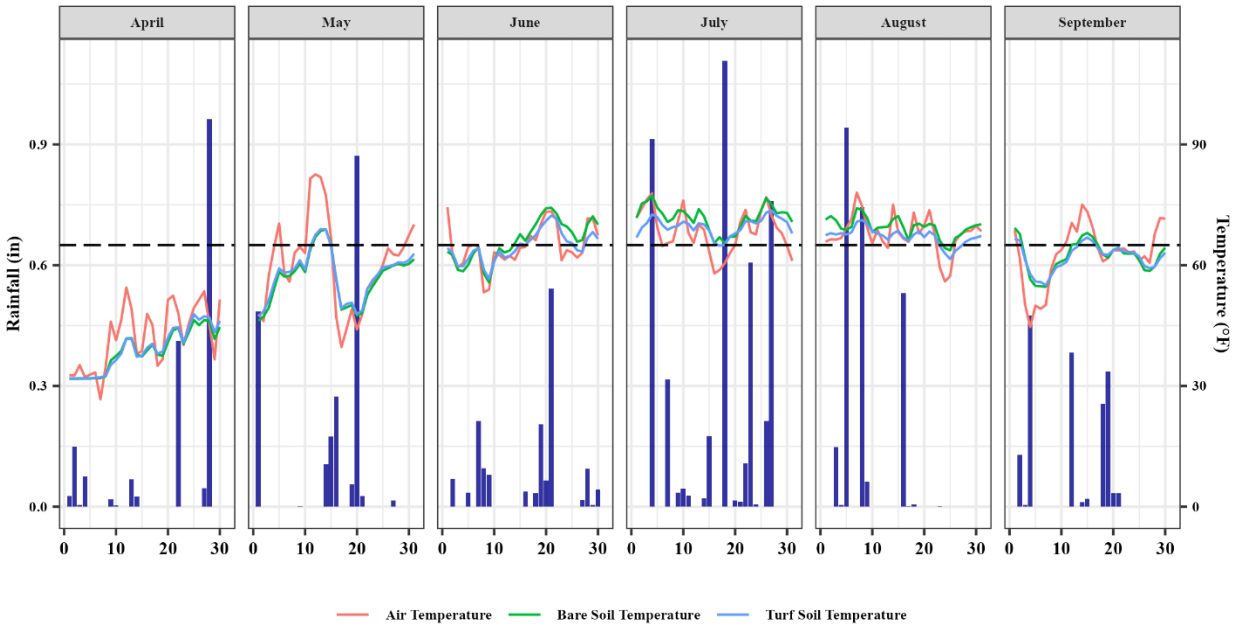
Supplementary Weather Table and Figure

Supplementary Table S1. Weather data for the 2025 growing season compared to the normal (30-year average). Data was retrieved from the Crookston Minnesota Agricultural Weather Network station (47.823333, -96.620556), located approximately 1.72 miles north-northwest of the research plots maintained by the Northwest Research and Outreach Center, Crookston, MN (47.801785, -96.600455).

Month	Total Rainfall (inch)		Average Air Temperature (°F)	
	2025	Normal [z]	2025	Normal [z]
April	1.79	1.27	41.8	40.8
May	2.01	2.75	59.8	54.7
June	1.52	4.15	63.6	65.2
July	4.36	3.27	67.6	69.1
August	2.44	2.97	68.2	67.4
September	1.68	2.6	62.8	58.2
Growing Season	**13.80**	**17.01**	**60.6**	**59.2**

[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 (bars) and daily mean air temperature (red line), and daily mean relative humidity (blue line) for the 2025 growing season recorded 0.63 miles north-northwest of research plots in Crookston, MN. The dotted horizontal line represents 65°F.

SUGARBEET PATHOLOGY LABORATORY: SUMMARY OF 2024-2025 FIELD SAMPLES

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INTRODUCTION AND OBJECTIVES

Each growing season, the Sugarbeet Plant Pathology Laboratory at the University of Minnesota, Northwest Research and Outreach Center in Crookston, MN, receives sugarbeet samples exhibiting disease, insect, or abiotic injury symptoms for diagnostic evaluation. The 2024 and 2025 seasons continued to reflect the dynamic nature of sugarbeet diseases in the American Crystal Sugar Company and Minn-Dak Farmers Cooperative growing districts in the Red River Valley of Minnesota and North Dakota, as well as the Southern Minnesota Beet Sugar Cooperative growing district. Variation in disease prevalence was influenced by fluctuating weather conditions and changing field environments. Notably, these years included expanded analysis of foliar diseases, in addition to the continued monitoring of major root pathogens such as *Rhizoctonia solani*, *Aphanomyces cochlioides*, and *Fusarium* spp. The following sections summarize diagnostic results and the observed trends for root and foliar diseases during 2024 and 2025.

MATERIALS AND METHODS

Accurate disease diagnosis depends heavily on the quality and condition of submitted samples. For root samples, plants exhibiting clear symptoms should be collected but those that are extensively decayed should be avoided, as secondary fungi can obscure primary pathogens. Roots should be placed in a resealable plastic (ziplock) bag containing a moist paper towel to maintain humidity without excessive free water. The likelihood of pathogen recovery is highest when samples are submitted the same day they are collected.

For leaf samples, place leaves in a resealable plastic bag with a dry paper towel to regulate humidity. Avoid leaving samples in vehicles or exposed to temperature extremes, as large fluctuations can accelerate tissue breakdown and reduce diagnostic quality.

Field sample submission forms are available on the Northwest Research and Outreach Center website: https://nwroc.umn.edu/research/sugar-beet-pathology

Upon receiving root samples, diseased sugarbeet roots were washed and photographed prior to sample preparation. Symptomatic tissue was excised, surface-sterilized in 0.5% sodium hypochlorite (NaOCl) for 30 s, rinsed twice with sterile deionized water, and placed into ultrafiltered deionized water. Following 24 to 48 h incubation at 21 ± 2 °C, roots were examined microscopically to confirm the presence of zoospore clusters characteristic of *Aphanomyces cochlioides* or right-angled hyphae typical of *Rhizoctonia solani*. Roots exhibiting symptoms consistent with *Fusarium* spp. infection were washed using the same procedure and plated onto acidified potato dextrose agar (APDA). After 5 to 7 days of incubation, colony morphology was used for preliminary identification. Single-spored *Fusarium* cultures were obtained for species-level identification by DNA extraction using a modified protocol using Wizard Genomic DNA purification kit (Promega) components and targeted sequencing of the translation elongation factor 1-α loci (EF1/EF2; O'Donnell et al. 1998). Species-level identification of *Colletotrichum* spp. isolates was conducted by using ITS1-F/ITS4 (Gardes and Bruns 1993; White et al. 1990), actin (ACT; Carbone and Kohn 1999), and β-tubulin (Btub; Woudenberg et al. 2009) primer sets.

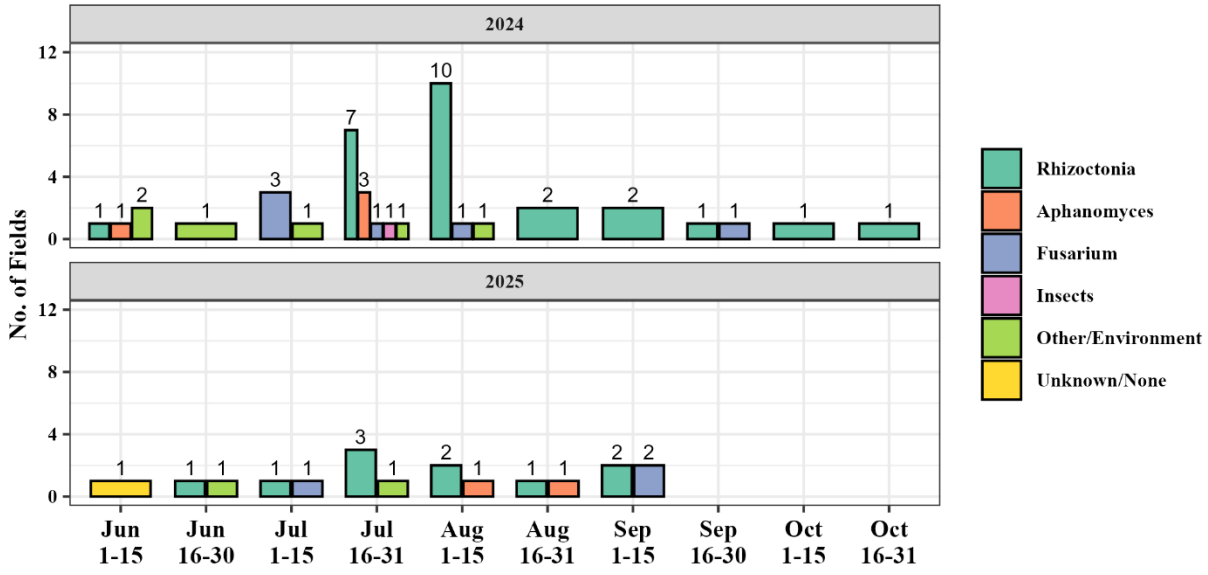
Upon receiving leaf samples, representative leaves were chosen and photographed. Representative leaf spots or lesions were excised and placed in bi-plate Petri dishes lined with absorbent paper saturated with sterile deionized water. One side of the paper was coated with an impermeable polyethylene and positioned face-up to maintain contact with the leaf tissue; plates were sealed with Parafilm. After 24 to 48 h incubation at 21 ± 2 °C under combined UV and fluorescent light with a 12 h light/dark cycle, conidia produced within lesions were examined microscopically. Single-spore cultures of *Alternaria* spp. and *Stemphylium* spp. grown on clarified V8 agar (CV8) were subjected to same DNA extraction protocol stated above, followed by PCR amplification and sequencing gene fragments of the internal transcribed spacer region (ITS1-F/ITS4; Gardes and Bruns 1993; White et al. 1990), calmodulin (CALD; Lawrence et al. 2013) and plasma membrane ATPase (Lawrence et al. 2013) loci.

Leaf spots that lacked visible fungal sporulation were tested for bacterial streaming by submerging symptomatic tissue in ultrafiltered deionized water and observing for exudate under a stereomicroscope. Suspect lesions were then excised and homogenized in potassium phosphate buffer (0.05 M) within 2 mL microcentrifuge tubes. After a 10-min incubation at room temperature, the suspension was diluted 1:10 and streaked onto nutrient broth yeast extract (NBY) agar to obtain single bacterial colonies. Single-colony cultures were grown in nutrient broth at 28°C on a shaker overnight prior to DNA extraction using the Wizard Genomic DNA purification kit (Promega). Representative isolates were subjected to targeted sequencing of the 16S-23S rRNA intergenic region (Guasp et al. 2000; Jensen et al. 1993) and housekeeping genes sigma factor 70 (*rpoD;* Sarkar and Guttman 2004), and gyrase B (*gyrB;* Sarkar and Guttman 2004) for species-level characterization.

RESULTS AND DISCUSSION

In 2024, sugarbeet root samples were received from 38 fields (254 individual roots). Of those fields, *R. solani* was identified from 25 fields (65.8%), *A. cochlioides* was identified from 4 fields (10.5%), and *Fusarium* spp. were identified from 6 fields (15.8%). Both *Fusarium oxysporum* and *Fusarium secorum* are typically isolated from sugarbeet roots with symptoms of Fusarium Yellows. There were 6 fields (15.8%) affected by possible environmental causes as no plant pathogens were detected, and 1 field (2.6%) had suspected sugarbeet root maggot injury (Fig. 1). In contrast, there was a lower number of submissions in 2025 (14 fields; 113 roots), but *R. solani* remained the dominant pathogen, detected in 10 fields (76.9%). *Aphanomyces cochlioides* was identified from 2 fields (15.4%), and *Fusarium* spp. were identified in 3 fields (23.1%) (Fig. 1). Wind damage affected 2 fields (15.4%) and unknown environmental issues affected 1 field (Fig. 1). *Colletotrichum* spp. were also identified in 2 fields (3.3%) in 2024, affecting the petioles of sugar beets and were associated with *R. solani* infections; a majority of isolates were identified as *Colletotrichum incanum*. In 2025, several fields had multiple issues; from the list above, 2 fields were affected by both *Rhizoctonia* and *Aphanomyces*, 2 fields were affected by both *Rhizoctonia* and *Fusarium*, and 1 field was affected by both *Rhizoctonia* and wind damage.

Fig. 1. Summary of sugarbeet root disease samples received by the Sugarbeet Plant Pathology Laboratory, University of Minnesota Northwest Research and Outreach Center, Crookston, MN in 2024 (top) and 2025 (bottom). Bars represent the number of fields diagnosed with each causal agent by the date range when samples were received.



The co-occurrence of *Rhizoctonia* with either *Aphanomyces* or *Fusarium* observed in several fields suggests overlapping environmental favorability for these pathogens. Rainfall patterns were notably different between 2024 and 2025 (Fig. 3). Spring and early-summer rainfall in 2024 was near or above the five-year average, while 2025 was drier with more localized precipitation (Fig. 3). The onset of *Aphanomyces* symptoms in early June corresponded with periods of saturated soils, whereas *Rhizoctonia* incidence peaked later in the season (July–August) under warmer, drier conditions following periods of saturated soil. *Fusarium* spp. were recovered sporadically from late June through September, often in fields planted with sugarbeet varieties susceptible to *Fusarium* spp.

Leaf diseases were increasingly prevalent in 2024 and 2025, marking a broader diagnostic focus compared to previous years. In 2024, leaf samples were received from 61 fields (454 leaves for a total of 3900 individual spots), and in 2025 from 21 fields (131 individual leaves; 1050 individual spots). *Cercospora beticola* remained the most common foliar pathogen, detected in 51 fields (83.6%) and 16 fields (76.2%) in 2024 and 2025, respectively (Fig. 2). However, the increasing frequency of *Alternaria* spp. and *Stemphylium vesicarium* was notable. In 2024, *Alternaria* spp. were present in 46 fields (75.4%), and *S. vesicarium* was present in 22 fields (36.1%), whereas *Alternaria* spp. were present in only 10 fields (47.6%) and *S. vesicarium* was not present in any field sample in 2025 (Fig. 2). *Alternaria* spp. and *S. vesicarium* were frequently observed within the same leaf spot.

In 2024, mean temperatures during June were notably cooler than normal, especially in the northern growing districts (Fig. 4), with frequent periods of moderate rainfall. These conditions likely favored the increased incidence of Alternaria and Stemphylium leaf spots, which are commonly associated with cooler, moist environments and physical injury to foliage caused by wind, hail, or other environmental stressors that compromise leaf tissue integrity. Two years of inoculated field trials (2024 and 2025) with *A. alternata* and *S. vesicarium* collected from Minnesota in the 2022 growing season have been conducted to better understand their pathogenicity, their interaction with sugarbeet varieties, and the efficacy of standard fungicide spray programs for management of leaf spot diseases caused by these pathogens. Results from these field trials will be summarized in a future manuscript.

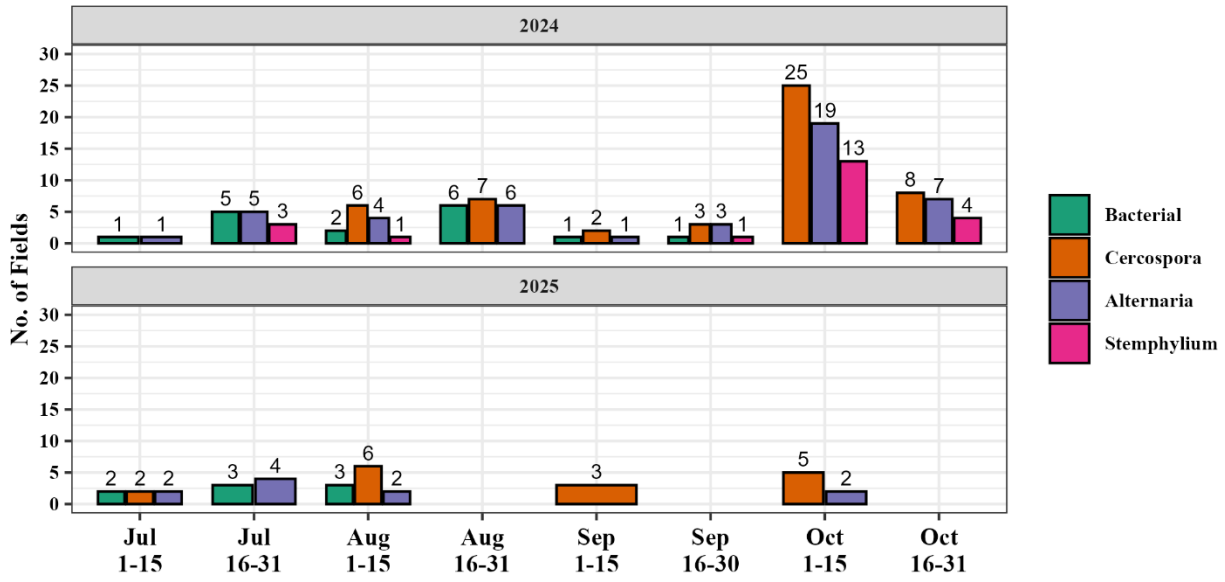


Fig. 2. Summary of sugarbeet foliar disease samples received by the Sugarbeet Plant Pathology Laboratory, University of Minnesota Northwest Research and Outreach Center, Crookston, MN in 2024 (top) and 2025 (bottom). Bars represent the number of fields diagnosed with each causal agent by the date range when samples were received.

Additionally, samples from 16 fields (26.2%) in 2024 and samples from 8 fields (38.1%) in 2025 were inconsistent with typical leaf spot symptoms, lacked fungal sporulation, and aligned with bacterial leaf spot symptoms. Cultures from these lesions yielded bacterial isolates currently being characterized through targeted gene sequencing as well as whole-genome sequencing to improve species-level identification. In addition, controlled growth chamber trials have been conducted to evaluate the pathogenicity of the bacterial strains collected in 2024. Results from these studies are summarized in a separate report. Weather patterns during 2024 and 2025 appeared to strongly influence the type and severity of foliar diseases observed. Wind events and canopy injury observed in both seasons may have further facilitated infection by opportunistic bacterial pathogens.

Diagnostic results from 2024 and 2025 highlight the continued dominance of *Rhizoctonia solani* among root pathogens and the growing importance of leaf diseases in regional sugarbeet production. The increasing occurrence of opportunistic fungi and bacterial leaf spots underscores the influence of weather-related stress and canopy injury on disease development. Ongoing molecular and pathogenicity studies will refine species identification and improve understanding of emerging foliar and bacterial pathogens affecting sugarbeet in Minnesota and North Dakota.

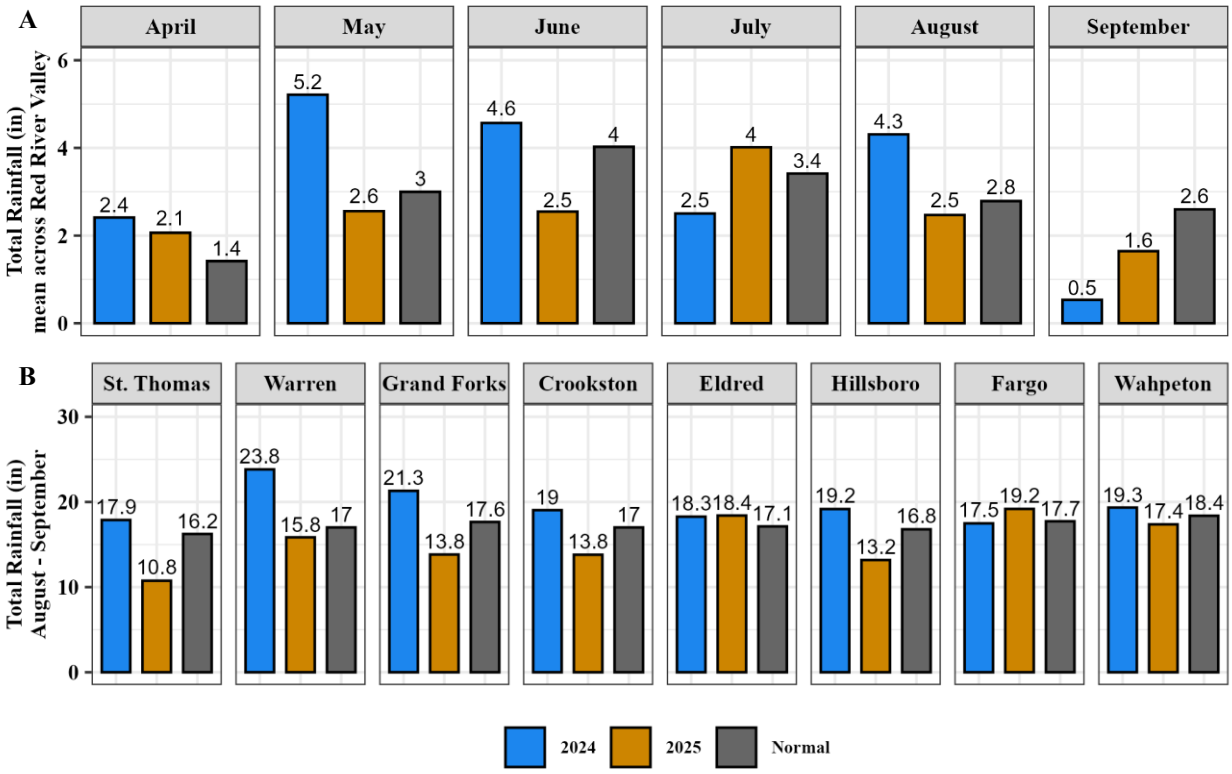


Fig. 3. Total rainfall recorded by the North Dakota Agricultural Weather Network (NDAWN) at eight locations in the Red River Valley (St. Thomas, Warren, Grand Forks, Crookston, Eldred, Hillsboro, Fargo, and Wahpeton). Rainfall is reported in inches for the growing season months of April through September in 2024 and 2025 compared to the 30-year average (normal). Rainfall is reported by **A.**) month (mean of all eight locations) and **B.**) location (total from April through September).

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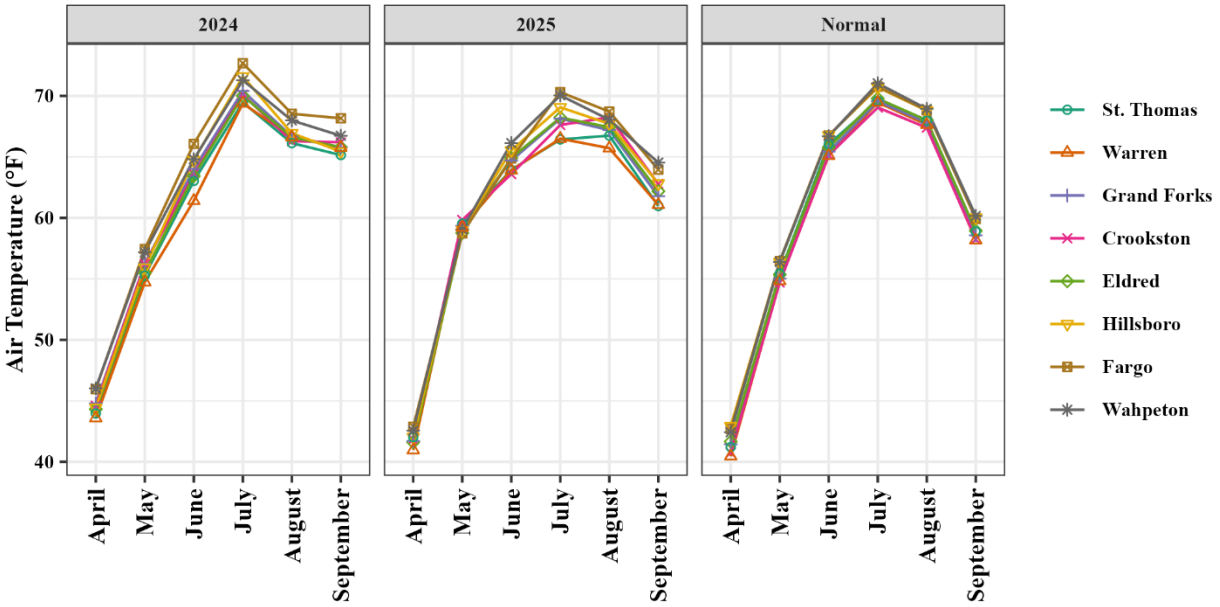

Fig. 4. Mean monthly air temperature recorded by the North Dakota Agricultural Weather Network (NDAWN) at eight locations in the Red River Valley (St. Thomas, Warren, Grand Forks, Crookston, Eldred, Hillsboro, Fargo, and Wahpeton). Temperature is reported in Fahrenheit for the growing season months of April through September in 2024 and 2025 compared to the 30-year average (normal).

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EVALUATION OF RHIZOMANIA RESISTANCE-BREAKING IN MINNESOTA AND NORTH DAKOTA SUGARBEET FIELDS

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Rhizomania is an economically important disease of sugarbeet that impacts crop productivity and grower profitability. The disease is caused by beet necrotic yellow vein virus (BNYVV), an RNA virus belonging to the family *Benyviridae* (Tamada and Baba, 1973). BNYVV is transmitted by *Polymyxa betae*, a soilborne obligate parasite of sugarbeet roots. In the United States, rhizomania was first detected in the early 1980 and rapidly spread to all sugarbeet production regions (Duffus, 1984; Wisler et al. 1997). Disease management has relied on genetic resistance such as *Rz1,* and other sources incorporated into commercial cultivars. However, in a few years, *Rz1*-mediated resistance was compromised by the emergence of resistance-breaking strains of BNYVV. Rhizomania symptoms appeared initially as blinkers and later widespread to large areas in fields planted with *Rz1* resistant cultivars (Scholten et al. 1996; Weiland et al., 2019). Although rhizomania has been managed by host resistance, symptoms are being observed in sugarbeet production fields, suggesting the appearance of resistance-breaking (RB) variants of BNYVV. Identification of these RB-variants of BNYVV is critical for developing future disease management strategies. Next-generation high-throughput sequencing offers a powerful approach to obtain comprehensive sequence information for both known and unknown viruses. In this study, rhizomania suspicious sugarbeet fields were identified, and soil samples were collected for evaluation. Soil-baiting assays were conducted using susceptible, *Rz1*, and *Rz1* plus *Rz2* seeds under laboratory conditions to assess resistance-breaking potential. Virus detection was performed using BNYVV-specific ELISA. Subsequently, HTS was applied to characterize nucleotide sequence changes in BNYVV and compare RB variants with non-resistance-breaking strains of BNYVV. Identifying these nucleotides and associated amino acid changes will allow the characterization of RB variants of BNYVV and provide insights for breeding and management strategies.

Methodology

A survey of rhizomania incidence was conducted in coordination with agriculturists and cooperatives across Minnesota and North Dakota including 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 that are suspicious of rhizomania, and resistance-breaking potential was assessed using soil-baiting assays with different sugarbeet genotypes, which were kindly provided by the seed company, SESVanderHave. Soil-baiting assay was carried in a greenhouse under standardized conditions at 24°C day and 18°C night with eight 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 samples consisting of three to four plants were 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 positive and negative controls to confirm the assay reagents in the diagnosis.

Results and Discussion

Rhizomania disease prevalence was monitored across sugarbeet growing regions of Minnesota and North Dakota in collaboration with the cooperatives and industry agriculturists. Symptoms of rhizomania were observed in multiple fields, and soil samples were collected from these locations for further analysis. Resistance-breaking was assessed in soil-baiting assays by growing sugarbeet varieties including susceptible type, Rz1, and Rz1Rz2. Detection of BNYVV in the root tissue of bait plants by ELISA confirmed the presence of rhizomania. When BNYVV was detected only in susceptible variety and not in Rz1 or Rz1Rz2, indicating that the soil contained rhizomania but did not overcome the resistance conferred by these genes. In contrast, detection of BNYVV in both resistant varieties as well as the susceptible variety indicates the presence of resistance-breaking strains of the virus in the soil. Out of 24 soil samples tested, BNYVV was detected in 18 samples. Among these, 16 samples were positive in the Rz1 variety, and 3 samples were positive in Rz1Rz2, indicating the presence of BNYVV strains capable of overcoming host resistance (Table 1). The ELISA was performed in triplicate, and the average values were used for analysis. Upon completion of the analysis, rhizomania resistance-breaking evaluation results were shared with cooperatives to guide informed decisions on crop rotation, cultural practices, and varietal selection. Overall, assessing resistance-breaking in field soil samples provides critical information for growers, enabling effective disease management strategies.

Table 1. Evaluation of rhizomania resistance breaking and ELISA detection of BNYVV. In the table symbols: ++, +, +/-, and - refers to highly positive, moderately positive, slightly positive, and negative for BNYVV, respectively.

Samples	Location	Susc.	Rz1	Rz1+Rz2
2025_Soil-L1	North Dakota	-	-	-
2025_Soil-L2	North Dakota	-	-	-
2025_Soil-L3	North Dakota	++	+	-
2025_Soil-L4	North Dakota	-	-	-
2025_Soil-L5	North Dakota	-	-	-
2025_Soil-L6	North Dakota	++	+	-
2025_Soil-L7	North Dakota	++	++	-
2025_Soil-L8	North Dakota	+	+	-
2025_Soil-L9	North Dakota	++	+/-	-
2025_Soil-L10	North Dakota	++	+	+/-
2025_Soil-L11	North Dakota	++	++	+/-
2025_Soil-L12	North Dakota	+	+	-
2025_Soil-L13	North Dakota	++	++	-
2025_Soil-L14	Minnesota	-	-	-
2025_Soil-L15	Minnesota	++	++	+/-
2025_Soil-L16	Minnesota	++	++	+/-
2025_Soil-L17	Minnesota	-	-	-
2025_Soil-L18	Minnesota	++	++	-
2025_Soil-L19	Minnesota	++	++	-
2025_Soil-L20	Minnesota	+/-	-	-
2025_Soil-L21	Minnesota	++	++	++
2025_Soil-L22	Minnesota	++	+	+
2025_Soil-L23	Minnesota	++	++	+/-
2025_Soil-L24	Minnesota	++	++	++

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SUGARBEET VARIETY TRIALS

RESULTS OF AMERICAN CRYSTAL SUGAR COMPANY'S 2025 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 2025 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 2026
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	2025 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, Horace, ND. 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 2025 official coded variety performance trials included 13 yield trials and 10 disease nurseries planted at a total of 17 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 25 to May 14 for yield trial sites. The Caledonia, ND site was replanted May 28 due to poor emergence caused by soil crusting. Stands in the trials varied from poor to excellent with most locations being good. Twelve of thirteen planted sites were harvested and used for variety approval calculations. The site at East Grand Forks, MN was abandoned due to poor emergence. Sites targeting Aphanomyces were located at Perley and Alvarado, MN, but moisture conditions were not favorable for Aphanomyces until later in the season when plants were not as susceptible. As a result, there is no new data for yield under Aphanomyces conditions. Rainfall amount and timing were sporadic for sites across the Red River Valley with some sites receiving ample rainfall for large yields and others affected by moisture stress. Coefficients of variation (CVs) for yield ranged from 3.9 to 6.8 (mean = 5.3) for Commercial trials and from 3.8 to 6.0 (mean = 4.7) for the Experimental trials. Percent sugar CVs ranged from 1.2 to 3.0 (mean =2.2) for the Commercial trials and from 1.7 to 3.9 (mean = 2.6) for the Experimental trials. Rhizoctonia crown and root rot was present at low levels at a few sites. Revenue calculations in 2025 are based on a hypothetical $60.97 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 naturally infested nurseries at Glyndon (Magno) and Shakopee (KWS), MN. Cercospora leafspot ratings are from inoculated nurseries at Randolph, MN (KWS) and Saginaw, MI (BSDF) as well as non-inoculated nurseries at Caledonia, ND and Averill and Stephen MN (ACSC). Correlation of Cercospora ratings among the three non-inoculated sites in the RRV and the inoculated site in MI were very good. 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 greenhouse assays at Moorhead (ACSC) and Shakopee (KWS), MN.

2025 harvest conditions were very good overall. Sites at Bathgate, ND and Northcote, MN with heavy soils were challenging to keep pinch wheels deep enough to dig smaller roots. Sugarbeet roots at most sites lifted very well.

The 2025 data have been combined with previous years' data for several tables. Results from 2025 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 varieties were not planted in the 2025 OVTs. Conventional varieties tested in 2017-2019 that were approved for 2020-2025 sales are permitted to continue in 2026 sales.

Yield trials were planted with regular pellets to stand at 4.5-inch seed spacing. 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 7-inch 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.

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. One or two applications of Roundup (25 oz/A) were made at the 2-4 and/or 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 7-inch 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, MN, and chlorpyrifos 4E (2pt/A) was applied at Reynolds and St Thomas, ND. Treatments used for Cercospora control in 2025 included Inspire XT/Manzate Max, Agri Tin/Topsin, Manzate Max, Proline/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 tare, 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 2026 Sugarbeet Crop

Roundup Ready ®	Full Market	Aph Spec	Rhc Spec	Rhizomania
BTS 8018	Yes	Yes	New	MG
BTS 8034	Yes	Yes		MG
BTS 8156	Yes	Yes		MG
BTS 8226	Yes	Yes	Yes	MG
BTS 8270	Yes	Yes	Yes	MG
BTS 8365	Yes	Yes	Yes	MG
BTS 8440	New	New	New	MG
BTS 8457	New		New	MG
BTS 8927	Yes	Yes	Yes	MG

Crystal 022	Yes	Yes	Yes	MG
Crystal 130	Yes	Yes	Yes	MG
Crystal 138	Yes	Yes	Yes	MG
Crystal 260	Yes	Yes	Yes	MG
Crystal 269	Yes	Yes		MG
Crystal 361	Yes	Yes	Yes	MG
Crystal 364	Yes	Yes	Yes	MG
Crystal 369	Yes	Yes		MG
Crystal 470	New	New	New	MG
Crystal 471	New	New	New	MG
Crystal 793	Yes	Yes		MG
Crystal 912	Yes	Yes	Yes	MG

Hilleshög HIL2389	Yes	Yes		MG
Hilleshög HIL2479	Yes			MG
Hilleshög HIL2480	No		Yes	MG
Hilleshög HIL2493	No		New	MG

Maribo MA717	Yes			MG

SX 1815	Yes			MG
SX 1835	No		Yes	MG

SV 231	Yes		Yes	MG
SV 345	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 10/21/2025

++ 2nd Year of not meeting Specialty Approval of previously approved Specialty variety. According to Approval Policy, may be sold as Specialty in 2026
+ 1st Year of not meeting Specialty Approval of previously approved Specialty variety. According to Approval Policy, may be sold as Specialty in 2026
Roundup Ready ® is a registered trademark of Bayer Group.

Table 2. Performance Data of RR Varieties During 2024 & 2025 Growing Seasons (All Locations Combined) Approved for Sale to ACSC Growers in 2026 +++

Variety	Yrs	Rev/Ton ++			Rev/Acre ++			Rec/Ton		Rec/Acre		Yield		Sugar		Molasses		Emergence +		Cerc. *		Aphan. *		Rhizoc. *		Fusarium *		Rzm *	
Com		25	2 Yr	2Y%	25	2 Yr	2Y%	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	25	2 Yr	
Number of locations →		12	24		12	24		12	24	12	24	12	24	12	24	12	24	12	24	5	10	2	5	4	8	2	4		
Previous Approved																													
BTS 8018	4	62.57	61.20	99	2179	2140	103	324	330	11348	11576	35.2	35.1	17.23	17.52	1.01	1.01	75	79	3.9	3.6	3.5	3.6	3.8	3.8	2.4	2.3	MG	
BTS 8034	4	58.73	57.30	93	2051	2015	97	314	319	11001	11239	35.2	35.3	16.83	17.09	1.14	1.15	67	76	4.3	4.0	3.5	4.0	4.2	4.3	2.3	2.1	MG	
BTS 8156	3	62.42	60.42	98	2130	2073	99	324	328	11082	11260	34.3	34.4	17.27	17.47	1.07	1.07	70	76	4.4	4.1	3.6	3.9	4.4	4.3	2.4	2.3	MG	
BTS 8226	2	66.83	65.01	105	2256	2201	106	336	341	11373	11568	34.0	34.0	17.74	18.01	0.95	0.96	73	77	4.1	3.8	3.4	3.6	3.6	3.5	2.9	2.8	MG	
BTS 8270	2	65.80	63.06	102	2189	2127	102	333	335	11114	11340	33.5	33.9	17.64	17.78	0.99	1.02	65	72	3.6	3.4	3.6	3.7	3.9	3.9	2.3	2.3	MG	
BTS 8365	1	67.89	66.20	107	2151	2120	102	339	344	10770	11051	31.9	32.1	17.91	18.19	0.98	0.96	64	72	4.0	4.1	3.7	3.8	3.7	3.7	2.6	2.4	MG	
BTS 8927	5	65.76	64.27	104	2215	2170	104	333	339	11262	11471	34.0	33.9	17.63	17.93	0.98	0.98	73	79	4.2	4.3	3.7	4.0	3.9	3.7	2.2	2.1	MG	
Crystal 022	4	67.03	64.74	105	2216	2130	102	336	340	11185	11219	33.4	33.1	17.80	18.00	0.98	0.99	74	77	4.8	4.7	3.3	3.6	3.9	3.7	2.3	2.5	MG	
Crystal 130	3	64.94	62.63	101	2213	2145	103	331	334	11312	11464	34.4	34.4	17.54	17.72	1.00	1.02	71	76	4.3	3.9	3.5	3.6	3.8	3.7	2.6	2.7	MG	
Crystal 138	2	65.28	62.18	100	2216	2120	102	332	333	11297	11361	34.2	34.2	17.59	17.68	1.00	1.04	68	73	4.5	4.6	3.6	3.7	3.8	3.7	2.6	2.8	MG	
Crystal 260	2	64.91	63.05	102	2219	2172	104	331	335	11333	11571	34.4	34.6	17.48	17.74	0.95	0.97	70	78	3.6	3.4	3.6	3.8	3.8	3.8	2.6	2.5	MG	
Crystal 269	2	65.76	64.28	104	2253	2196	105	333	339	11455	11612	34.5	34.3	17.74	18.04	1.09	1.09	69	73	4.4	4.5	3.1	3.3	4.1	4.2	2.3	2.4	MG	
Crystal 361	1	67.32	64.21	104	2282	2200	106	337	339	11455	11623	34.1	34.4	17.80	17.90	0.94	0.98	74	77	3.7	3.5	3.1	3.5	4.0	3.9	2.3	2.2	MG	
Crystal 364	NC	60.09	58.58	95	2162	2122	102	318	323	11497	11724	36.5	36.5	16.96	17.21	1.07	1.08	78	81	4.4	4.4	3.4	3.6	3.6	3.7	2.2	2.2	MG	
Crystal 369	1	63.41	62.00	100	2214	2158	103	327	332	11445	11585	35.2	34.9	17.43	17.74	1.10	1.11	68	75	3.9	4.0	3.4	3.4	4.3	4.5	2.3	2.3	MG	
Crystal 793	7	64.00	62.37	101	2220	2156	103	328	334	11427	11542	35.0	34.7	17.40	17.68	0.99	1.00	75	78	4.0	4.1	3.2	3.4	4.2	4.0	2.5	2.4	MG	
Crystal 912	4	57.95	55.64	90	2174	2105	101	312	314	11742	11896	37.8	37.9	16.66	16.79	1.07	1.09	74	79	5.0	5.0	3.3	3.4	3.1	3.3	4.2	3.9	MG	
Hilleshög HIL2389	3	63.20	61.65	100	2116	2089	100	326	331	10945	11243	33.7	34.0	17.31	17.58	1.01	1.01	67	76	4.5	4.6	3.8	3.7	4.0	4.0	5.4	5.5	MG	
Hilleshög HIL2479	1	62.71	61.64	100	2067	1968	94	325	332	10751	10601	33.2	32.1	17.30	17.64	1.06	1.06	72	75	4.2	4.2	4.2	4.5	3.5	3.9	4.5	4.5	MG	
Hilleshög HIL2480 **	1	60.90	59.58	96	2052	1969	94	320	326	10818	10772	34.0	33.2	17.19	17.48	1.20	1.20	69	74	4.2	4.2	4.1	4.2	3.4	3.5	2.6	2.8	MG	
Maribo MA717	7	59.56	57.69	93	2065	2022	97	316	320	11043	11260	35.2	35.3	16.89	17.08	1.08	1.08	64	72	4.8	4.8	4.9	4.5	3.9	4.0	5.1	4.7	MG	
SX 1815	3	62.66	61.52	99	2097	2084	100	325	331	10925	11244	33.9	34.0	17.25	17.58	1.02	1.02	65	74	4.7	4.7	4.3	4.1	4.1	4.2	6.1	5.8	MG	
SX 1835 **	1	59.93	57.94	94	2160	2110	101	317	321	11469	11703	36.3	36.5	16.96	17.16	1.10	1.12	72	79	4.6	4.6	4.4	4.4	3.8	3.9	4.7	4.1	MG	
SV 231	1	60.80	58.69	95	2179	2147	103	320	323	11491	11833	36.1	36.6	17.02	17.20	1.04	1.05	75	79	4.7	4.8	4.1	4.3	3.8	3.8	5.1	4.8	MG	
Newly Approved																													
BTS 8440	NC	67.86	64.75	105	2290	2197	105	339	340	11469	11564	34.0	34.1	17.86	17.94	0.92	0.94	74	78	3.2	3.0	3.6	3.8	3.8	3.7	2.5	2.7	MG	
BTS 8457	NC	65.74	63.75	103	2228	2194	105	333	337	11344	11646	34.3	34.6	17.54	17.78	0.90	0.92	73	76	4.1	3.8	4.0	4.1	3.8	3.7	2.7	2.5	MG	
Crystal 470	NC	63.15	60.93	98	2247	2196	105	326	329	11623	11883	35.8	36.1	17.29	17.47	0.98	1.00	73	78	4.2	4.0	3.7	3.7	3.8	3.8	2.7	2.5	MG	
Crystal 471	NC	66.82	64.59	104	2251	2204	106	336	340	11370	11631	34.0	34.3	17.74	17.96	0.95	0.97	69	75	4.1	3.8	3.6	3.8	3.9	3.8	2.4	2.3	MG	
Hilleshög HIL2493 **	NC	60.14	58.67	95	2164	2157	103	318	323	11486	11910	36.3	37.0	16.95	17.21	1.06	1.06	73	77	4.6	4.7	4.3	4.2	3.6	3.7	4.4	4.6	MG	
SV 345 **	NC	60.41	57.76	93	2147	2138	103	318	320	11366	11891	35.9	37.2	17.00	17.08	1.07	1.07	69	78	4.8	4.9	4.1	4.2	3.6	3.5	4.9	4.6	MG	
Benchmark var. mean		64.15	61.90		2150	2085		329	332	11049	11201	33.8	33.8	17.44	17.64	1.01	1.03	71	78										

+++ 2025 Sites include Casselton, Averill, Perley, Ada, Caledonia, Scandia, Reynolds, Alvarado, Stephen, St Thomas, Northcote, and Bathgate

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+++ 2024 Sites include Casselton, Averill, Ada, Hillsboro, Climax, Grand Forks, Scandia, Forest River, Alvarado, St Thomas, Hallock, and Bathgate

++ 2025 Revenue estimate based on a $60.97 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses and 2024 Revenue estimate based on a $54.53 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses.

+ Emergence is % of planted seeds producing a 4 leaf beet.

** Does not meet Full Market Approval. Meets Aphanomyces and/or Rhizoctonia Specialty Approval .

* 2025 Cercospora from Saginaw MI, Randolph MN, Averill MN, Caledonia ND and Stephen MN (res.<4.4, susc>5.0). Aphanomyces ratings from Shakopee MN and Glyndon 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.

* 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).

Table 3. Performance Data of RR 2025 Approved Varieties Under Aphanomyces Conditions +++

Variety	Yrs Com	Aph Spc +	Rev/Ton++ 2024	Rev/Ton++ %Mn	Rev/Ton++ 2020	Rev/Ton++ %Mn^	Rev/Acre++ 2024	Rev/Acre++ %Mn	Rev/Acre++ 2020	Rev/Acre++ %Mn^	Rec/Ton 2024	Rec/Ton 2020	Rec/Acre 2024	Rec/Acre 2020	Sugar 2024	Sugar 2020	Yield 2024	Yield 2020	Cerc. * 25	Cerc. * 2Yr	Aphan. * 25	Aphan. * 2 Yr	Rhizoc. * 25	Rhizoc. * 2Yr	Fusarium * 25	Fusarium * 2Yr
Number of locations →			1		3		1		3		1	3	1	3	1	3	1	3	5	9	2	5	4	8	2	4
Previous Approved																										
BTS 8018	4	Yes	59.33	98	40.59	107	1396	111	982	112	334.6	303.9	7861	7256	17.81	16.22	23.43	23.62	3.88	3.62	3.51	3.62	3.83	3.75	2.42	2.31
BTS 8034	4	Yes	59.65	99	35.57	94	1446	115	887	102	335.5	286.7	8117	7046	17.89	15.53	24.14	24.32	4.28	3.99	3.52	4.00	4.20	4.29	2.31	2.10
BTS 8156	3	Yes	61.11	101	--	--	1379	110	--	--	339.9	--	7678	--	18.06	--	22.60	--	4.38	4.12	3.59	3.93	4.38	4.33	2.36	2.25
BTS 8226	2	Yes	64.54	107	--	--	1409	112	--	--	350.3	--	7641	--	18.48	--	21.79	--	4.05	3.79	3.43	3.62	3.64	3.55	2.91	2.77
BTS 8270	2	Yes	62.52	103	--	--	1371	109	--	--	344.2	--	7542	--	18.23	--	21.89	--	3.56	3.44	3.61	3.69	3.85	3.85	2.28	2.34
BTS 8365	1	Yes	65.38	108	--	--	1387	111	--	--	353.0	--	7498	--	18.66	--	20.96	--	3.95	4.07	3.69	3.78	3.73	3.67	2.56	2.35
BTS 8927	5	Yes	63.12	104	43.12	114	1298	103	985	113	346.0	312.6	7102	7070	18.33	16.58	20.46	22.44	4.22	4.34	3.67	4.04	3.87	3.72	2.18	2.14
Crystal 022	4	Yes	66.63	110	44.07	117	1453	116	1047	120	356.6	315.8	7782	7422	18.81	16.80	21.85	23.24	4.78	4.72	3.33	3.64	3.87	3.75	2.33	2.54
Crystal 130	3	Yes	58.82	97	--	--	1385	110	--	--	333.0	--	7839	--	17.72	--	23.53	--	4.27	3.92	3.46	3.59	3.79	3.67	2.58	2.67
Crystal 138	2	Yes	64.24	106	--	--	1391	111	--	--	349.4	--	7576	--	18.50	--	21.77	--	4.47	4.60	3.56	3.70	3.77	3.73	2.60	2.79
Crystal 260	2	Yes	60.37	100	--	--	1364	109	--	--	337.7	--	7634	--	17.94	--	22.61	--	3.60	3.37	3.58	3.83	3.80	3.75	2.64	2.51
Crystal 269	2	Yes	61.85	102	--	--	1405	112	--	--	342.2	--	7758	--	18.14	--	22.61	--	4.42	4.48	3.07	3.29	4.06	4.18	2.28	2.41
Crystal 361	1	Yes	60.40	100	--	--	1262	101	--	--	337.9	--	7080	--	18.03	--	21.01	--	3.71	3.52	3.13	3.47	3.99	3.88	2.31	2.16
Crystal 364	NC	Yes	55.79	92	--	--	1293	103	--	--	323.7	--	7556	--	17.23	--	23.38	--	4.37	4.41	3.38	3.58	3.60	3.69	2.23	2.18
Crystal 369	1	Yes	60.53	100	--	--	1272	101	--	--	338.3	--	7128	--	18.01	--	21.06	--	3.88	3.96	3.35	3.40	4.27	4.49	2.28	2.27
Crystal 793	7	Yes	61.18	101	37.97	101	1316	105	886	101	340.1	294.9	7324	6732	18.02	15.80	21.56	22.43	3.98	4.13	3.17	3.45	4.18	4.04	2.46	2.43
Crystal 912	4	Yes	53.61	89	35.21	93	1207	96	886	101	317.3	285.5	7142	7041	16.92	15.44	22.52	24.35	5.04	5.05	3.27	3.42	3.12	3.29	4.25	3.86
Hilleshög HIL2389	3	Yes	60.04	99	--	--	1301	104	--	--	336.7	--	7312	--	17.86	--	21.77	--	4.53	4.55	3.80	3.68	4.01	4.04	5.44	5.46
Hilleshög HIL2479	1	No	58.75	97	--	--	729	58	--	--	332.8	--	4074	--	17.82	--	11.93	--	4.21	4.23	4.18	4.47	3.50	3.87	4.46	4.53
Hilleshög HIL2480 **	1	No	60.05	99	--	--	963	77	--	--	336.8	--	5435	--	18.02	--	16.33	--	4.24	4.16	4.06	4.25	3.37	3.51	2.62	2.84
Maribo MA717	7	No	55.88	92	34.86	92	976	78	731	84	324.1	284.0	5649	5834	17.30	15.24	17.42	20.22	4.82	4.83	4.88	4.53	3.90	4.05	5.06	4.71
SX 1815	3	No	62.01	103	--	--	1353	108	--	--	342.6	--	7471	--	18.16	--	21.78	--	4.74	4.72	4.28	4.12	4.09	4.20	6.05	5.80
SX 1835 **	1	No	58.83	97	--	--	1124	90	--	--	333.0	--	6430	--	17.70	--	19.45	--	4.60	4.63	4.43	4.37	3.79	3.93	4.69	4.10
SV 231	1	No	59.63	99	--	--	1191	95	--	--	335.5	--	6783	--	17.73	--	20.45	--	4.73	4.75	4.11	4.27	3.81	3.76	5.06	4.84
Newly Approved																										
BTS 8440	NC	Yes	64.45	107	--	--	1310	104	--	--	350.2	--	7132	--	18.50	--	20.44	--	3.18	3.04	3.61	3.82	3.82	3.75	2.49	2.73
BTS 8457	NC	No	61.39	102	--	--	1259	100	--	--	340.8	--	7039	--	17.99	--	20.82	--	4.07	3.81	3.96	4.15	3.76	3.74	2.69	2.52
Crystal 470	NC	Yes	58.51	97	--	--	1186	95	--	--	332.0	--	6662	--	17.62	--	19.64	--	4.21	3.96	3.74	3.71	3.78	3.82	2.73	2.49
Crystal 471	NC	Yes	63.47	105	--	--	1274	102	--	--	347.1	--	6988	--	18.37	--	20.00	--	4.10	3.79	3.62	3.81	3.86	3.77	2.40	2.25
Hilleshög HIL2493 **	NC	No	59.64	99	--	--	1226	98	--	--	335.5	--	6915	--	17.75	--	20.68	--	4.65	4.74	4.27	4.21	3.56	3.69	4.38	4.55
SV 345 **	NC	No	58.74	97	--	--	1046	83	--	--	332.7	--	5920	--	17.63	--	17.70	--	4.84	4.89	4.12	4.16	3.59	3.54	4.94	4.65
AP CK SUS RR#2			56.88	94	--	--	687	55	--	--	327.1	--	3975	--	17.45	--	12.40	--								
Trial mean (includes AP CK SUS RR#2)			60.45	100	--	--	1254	100	--	--	337.9	--	7016	--	17.95	--	20.75	--								
AP SUS RR#5			--	--	30.80	82	--	--	590	67	--	269.8	--	4984	--	14.75	--	18.00								
Trial mean (includes AP SUS RR#5)			--	--	37.77	100	--	--	874	100	--	294.1	--	6673	--	15.79	--	22.33								
Mean of specialty varieties			61.1	101	39.42	104	1352	108	946	108	339.8	299.9	7532	7095	18.04	16.06	22.16	23.40								

+++ 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 2025 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.

* 2025 Cercospora from Saginaw MI, Randolph MN, Averill MN, Caledonia ND and Stephen MN (res.<4.4, susc>5.0). Aphanomyces ratings from Shakopee MN and Glyndon MN (res.<4.0, susc>4.8).

Rhizoctonia from Saginaw MI, Moorhead MN (two sites) 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.

* 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 (two sites) and Crookston MN (res.<3.8, susc>5). Fusarium 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	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 10/21/2025

+++ 2018 Sites include Casselton, Ada, Grand Forks, Scandia, and St. Thomas

+++ 2017 Sites include 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 2023-2025 (Varieties tested in 2025) Cercospora, Aphanomyces, Rhizoctonia & Fusarium

		< 4.5 Cercospora > 5.0					< 4.0 Aphanomyces > 4.8					<3.82 Rhizoctonia > 5.0					< 3.0 Fusarium > 5.0					Rhizomania
		25	24	23	2 Yr	3 Yr	25	24	23	2 Yr	3 Yr	25	24	23	2 Yr	3 Yr	25	24	23	2 Yr	3 Yr	
Code	Description	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	
	Previously Approved																					
534	BTS 8018	3.88	3.35	2.42	3.62	3.22	3.51	3.73	3.95	3.62	3.73	3.83	3.68	4.06	3.75	3.86	2.42	2.19	3.20	2.31	2.61	MG
506	BTS 8034	4.28	3.69	2.54	3.99	3.51	3.52	4.48	3.80	4.00	3.93	4.20	4.38	4.09	4.29	4.22	2.31	1.89	2.72	2.10	2.31	MG
529	BTS 8156	4.38	3.87	2.53	4.12	3.59	3.59	4.27	3.97	3.93	3.94	4.38	4.28	3.93	4.33	4.20	2.36	2.15	2.80	2.25	2.44	MG
504	BTS 8226	4.05	3.52	2.33	3.79	3.30	3.43	3.81	3.72	3.62	3.65	3.64	3.46	3.78	3.55	3.62	2.91	2.64	3.85	2.77	3.13	MG
549	BTS 8270	3.56	3.32	2.43	3.44	3.10	3.61	3.76	3.90	3.69	3.76	3.85	3.86	3.67	3.85	3.79	2.28	2.41	3.46	2.34	2.71	MG
505	BTS 8365	3.95	4.18	4.15	4.07	4.10	3.69	3.87	3.62	3.78	3.73	3.73	3.60	3.69	3.67	3.67	2.56	2.15	3.43	2.35	2.71	MG
512	BTS 8927	4.22	4.45	4.38	4.34	4.35	3.67	4.41	3.26	4.04	3.78	3.87	3.57	3.98	3.72	3.81	2.18	2.10	3.08	2.14	2.45	MG
537	Crystal 022	4.78	4.66	4.97	4.72	4.81	3.33	3.95	3.66	3.64	3.65	3.87	3.63	3.85	3.75	3.78	2.33	2.75	3.43	2.54	2.84	MG
525	Crystal 130	4.27	3.56	2.60	3.92	3.48	3.46	3.72	4.00	3.59	3.73	3.79	3.54	3.69	3.67	3.67	2.58	2.76	3.55	2.67	2.96	MG
545	Crystal 138	4.47	4.73	4.77	4.60	4.66	3.56	3.84	4.06	3.70	3.82	3.77	3.68	3.81	3.73	3.76	2.60	2.98	3.76	2.79	3.11	MG
517	Crystal 260	3.60	3.13	2.15	3.37	2.96	3.58	4.08	3.84	3.83	3.83	3.80	3.70	3.46	3.75	3.65	2.64	2.38	3.38	2.51	2.80	MG
503	Crystal 269	4.42	4.54	4.38	4.48	4.45	3.07	3.50	3.62	3.29	3.40	4.06	4.30	3.90	4.18	4.09	2.28	2.54	4.11	2.41	2.98	MG
546	Crystal 361	3.71	3.33	2.24	3.52	3.09	3.13	3.80	3.45	3.47	3.46	3.99	3.78	3.54	3.88	3.77	2.31	2.02	3.24	2.16	2.52	MG
539	Crystal 364	4.37	4.46	4.26	4.41	4.36	3.38	3.78	3.79	3.58	3.65	3.60	3.77	3.79	3.69	3.72	2.23	2.12	3.12	2.18	2.49	MG
542	Crystal 369	3.88	4.03	3.78	3.96	3.90	3.35	3.45	4.02	3.40	3.61	4.27	4.72	3.98	4.49	4.32	2.28	2.25	3.24	2.27	2.59	MG
516	Crystal 793	3.98	4.28	4.20	4.13	4.15	3.17	3.72	4.31	3.45	3.73	4.18	3.89	4.35	4.04	4.14	2.46	2.40	3.40	2.43	2.76	MG
536	Crystal 912	5.04	5.06	5.00	5.05	5.03	3.27	3.57	3.41	3.42	3.42	3.12	3.45	3.50	3.29	3.36	4.25	3.46	3.82	3.86	3.84	MG
532	Hilleshög HIL2389	4.53	4.57	4.51	4.55	4.54	3.80	3.56	5.42	3.68	4.26	4.01	4.08	4.45	4.04	4.18	5.44	5.49	5.50	5.46	5.47	MG
538	Hilleshög HIL2479	4.21	4.25	4.09	4.23	4.18	4.18	4.76	4.38	4.47	4.44	3.50	4.24	3.43	3.87	3.72	4.46	4.59	4.43	4.53	4.50	MG
524	Hilleshög HIL2480 **	4.24	4.08	4.00	4.16	4.11	4.06	4.43	4.30	4.25	4.26	3.37	3.65	3.70	3.51	3.57	2.62	3.06	3.30	2.84	2.99	MG
527	Maribo MA717	4.82	4.85	5.04	4.83	4.90	4.88	4.18	4.61	4.53	4.55	3.90	4.19	4.10	4.05	4.07	5.06	4.36	4.53	4.71	4.65	MG
533	SX 1815	4.74	4.70	4.74	4.72	4.73	4.28	3.96	6.15	4.12	4.80	4.09	4.30	4.35	4.20	4.25	6.05	5.54	5.60	5.80	5.73	MG
530	SX 1835 **	4.60	4.66	4.55	4.63	4.60	4.43	4.31	5.99	4.37	4.91	3.79	4.07	3.55	3.93	3.80	4.69	3.52	3.92	4.10	4.04	MG
526	SV 231	4.73	4.77	4.83	4.75	4.78	4.11	4.43	6.25	4.27	4.93	3.81	3.71	3.69	3.76	3.74	5.06	4.62	4.21	4.84	4.63	MG
	Newly Approved																					
511	BTS 8440	3.18	2.90	--	3.04	--	3.61	4.03	--	3.82	--	3.82	3.68	--	3.75	--	2.49	2.97	--	2.73	--	MG
518	BTS 8457	4.07	3.55	--	3.81	--	3.96	4.33	--	4.15	--	3.76	3.71	--	3.74	--	2.69	2.35	--	2.52	--	MG
522	Crystal 470	4.21	3.71	--	3.96	--	3.74	3.67	--	3.71	--	3.78	3.85	--	3.82	--	2.73	2.25	--	2.49	--	MG
548	Crystal 471	4.10	3.49	--	3.79	--	3.62	3.99	--	3.81	--	3.86	3.69	--	3.77	--	2.40	2.10	--	2.25	--	MG
553	Hilleshög HIL2493 **	4.65	4.82	--	4.74	--	4.27	4.15	--	4.21	--	3.56	3.83	--	3.69	--	4.38	4.72	--	4.55	--	MG
535	SV 345 **	4.84	4.93	--	4.89	--	4.12	4.20	--	4.16	--	3.59	3.48	--	3.54	--	4.94	4.35	--	4.65	--	MG

Created 10/21/2025

** 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
ACSC, KWS and Magno Seed from 2023 - 2025

		Moorhead, MN[X] (1=Exc - 4=Poor)					Shakopee, MN[Y] (1=Exc - 4=Poor)					Longmont, CO[Z] (% Infested Plants)				
Code	Variety	2023*	2024	2025	2 Yr	3 Yr	2023	2024	2025	2 Yr	3 Yr	2023**	2024	2025**	2 Yr	3 Yr
721	BTS 8018	--	1.17	1.33	1.25	--	1.16	1.00	1.00	1.00	1.05	--	5.00	--	--	--
716	BTS 8034	--	1.00	1.33	1.17	--	1.28	1.00	1.00	1.00	1.09	--	7.86	--	--	--
712	BTS 8156	--	1.00	1.33	1.17	--	1.20	1.04	1.04	1.04	1.09	--	3.00	--	--	--
714	BTS 8226	--	1.00	1.17	1.08	--	1.00	1.04	1.08	1.06	1.04	--	2.91	--	--	--
729	BTS 8270	--	1.00	1.17	1.08	--	1.08	1.04	1.12	1.08	1.08	--	4.79	--	--	--
732	BTS 8365	--	1.00	1.33	1.17	--	--	1.12	1.00	1.06	--	--	1.35	--	--	--
724	BTS 8440	--	--	1.17	--	--	--	--	1.04	--	--	--	--	--	--	--
706	BTS 8457	--	--	1.33	--	--	--	--	1.00	--	--	--	--	--	--	--
731	BTS 8927	--	1.00	1.50	1.25	--	1.12	1.08	1.00	1.04	1.07	--	3.97	--	--	--
708	Crystal 022	--	1.00	1.00	1.00	--	1.04	1.00	1.08	1.04	1.04	--	1.92	--	--	--
710	Crystal 130	--	1.00	1.17	1.08	--	1.00	1.12	1.04	1.08	1.05	--	5.10	--	--	--
701	Crystal 138	--	1.00	1.17	1.08	--	1.04	1.00	1.00	1.00	1.01	--	2.45	--	--	--
730	Crystal 260	--	1.00	1.00	1.00	--	1.12	1.04	1.00	1.02	1.05	--	1.04	--	--	--
719	Crystal 269	--	1.00	1.00	1.00	--	1.04	1.04	1.00	1.02	1.03	--	8.60	--	--	--
722	Crystal 361	--	1.00	1.17	1.08	--	--	1.04	1.00	1.02	--	--	2.16	--	--	--
707	Crystal 364	--	1.00	1.50	1.25	--	--	1.08	1.04	1.06	--	--	3.58	--	--	--
702	Crystal 369	--	1.00	1.00	1.00	--	--	1.04	1.08	1.06	--	--	7.20	--	--	--
718	Crystal 470	--	--	1.17	--	--	--	--	1.04	--	--	--	--	--	--	--
720	Crystal 471	--	--	1.17	--	--	--	--	1.00	--	--	--	--	--	--	--
728	Crystal 793	--	1.00	1.33	1.17	--	1.08	1.12	1.00	1.06	1.07	--	5.00	--	--	--
715	Crystal 912	--	1.00	1.50	1.25	--	1.04	1.04	1.00	1.02	1.03	--	10.92	--	--	--
711	Hilleshög HIL2389	--	1.67	2.50	2.08	--	2.04	2.04	2.32	2.18	2.13	--	11.03	--	--	--
709	Hilleshög HIL2479	--	1.00	1.50	1.25	--	--	PE	1.16	--	--	--	1.52	--	--	--
726	Hilleshög HIL2480	--	1.00	1.33	1.17	--	--	1.20	1.08	1.14	--	--	3.33	--	--	--
703	Hilleshög HIL2493	--	--	2.00	--	--	--	--	1.88	--	--	--	--	--	--	--
713	Hilleshög HIL2494	--	--	2.50	--	--	--	--	2.08	--	--	--	--	--	--	--
704	Maribo MA717	--	1.67	3.17	2.42	--	3.40	3.12	2.40	2.76	2.97	--	5.86	--	--	--
705	SX 1815	--	1.00	2.00	1.50	--	2.36	1.76	1.48	1.62	1.87	--	3.01	--	--	--
723	SX 1835	--	1.83	1.83	1.83	--	--	1.64	1.76	1.70	--	--	2.78	--	--	--
727	SV 231	--	1.67	2.50	2.08	--	--	2.04	1.56	1.80	--	--	0.00	--	--	--
717	SV 345	--	--	1.67	--	--	--	--	2.04	--	--	--	--	--	--	--
725	SV 347	--	--	2.33	--	--	--	--	2.00	--	--	--	--	--	--	--
733	Root Aphid Res CK#3	--	1.00	1.33	1.17	--	1.08	1.00	1.00	1.00	1.03	--	5.27	--	--	--
734	Root Aphid Susc CK#6	--	2.33	3.33	2.83	--	3.20	2.48	2.21	2.35	2.63	--	4.20	--	--	--
735	Root Aphid Susc CK#8	--	2.17	3.33	2.75	--	--	3.76	2.60	3.18	--	--	3.75	--	--	--
736	Root Aphid Res CK#4	--	--	1.67	--	--	--	--	1.00	--	--	--	--	--	--	--
	Trial Mean	1.63					1.34									
	Sus. Check Mean	3.33					2.41									
	Mean LSD (0.05)	0.69					0.37									

[X] Growth room assay based on a 1-4 rating scale (1 = no aphids, 4 = very susceptible), Moorhead, MN, ACSC

Created 11/17/2025

[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

* Growth room assay not conducted

** No data available due to low root aphid levels

PE = not evaluated due to poor emergence

Table 7. Planting & Harvest Dates, Previous Crop and Disease Levels for 2025 ACSC Official Trial Sites *

Yield Trials Location	District / Trial Type	Cooperator	Planting Date	Harvest Date	Preceding Crop	Soil Type	Diseases Present @ Aph	Rhc	Rzm	Fus	Maggot	Rt Aphid	Comments
Casselton ND	Mhd	Todd Weber Farms	5/6	10/4	Wheat	Medium	L-M	L	N	N	N	N	Very good overall
Averill MN	Mhd	Tang Farms	5/10	9/8	Wheat	Medium/Light	N	N	N	N	N	N	Very good overall
Perley MN	Mhd/Aph	TD Hoff Partnership	5/7	10/3	Wheat	Heavy	L	L	N	N	N	N	Lower and variable stands
Ada MN	Hill	Mark Maring	4/25	9/9	Wheat	Medium	N	N	N	N	N	N	Very good overall, Cerc. developing prior to harvest
Caledonia ND	Hill	Cotton Farms	5/28	10/2	Wheat	Medium/Light	N	N	N	N	N	N	Replanted with excellent uniformity
Scandia MN	Crk	Deboer Farms	4/25	9/29	Wheat	Medium	N	N	N	N	N	N	Early nurse crop competition, some rows dropped due to row 7 planter issue
Reynolds ND	EGF	Drees Farming Association	5/8	9/10	Wheat	Medium/Light	N	N	N	N	N	N	Excellent overall
East Grand Forks MN	EGF	Mark Holy	5/14	--	Wheat	Medium	N	N	N	N	N	N	Abandoned due to poor emergence
Alvarado MN	EGF	Nordling Farms	5/9	9/24	Wheat	Heavy	L	N	N	N	N	N	Some gappy stands but uniform canopy
Stephen MN	Dtn	Brent Riopelle	4/26	9/23	Wheat	Heavy	N	N	N	N	N	L	Excellent overall, late moisture stress
St Thomas ND	Dtn	Baldwin Farms	5/4	9/16	Wheat	Light	N	N	N	N	L-M	N	Very good overall, Verticillium wilt present
Northcote MN	Dtn	Younggren Farms	4/26	9/18	Wheat	Heavy	N	L	N	N	N	N	Some rows dropped due to tillage wheel track effects
Bathgate ND	Dtn	McColl Farms	5/3	9/26	Wheat	Medium/Heavy	N	L	N	N	N	N	Lower and variable stands

Disease Trials Location	District / Trial Type	Cooperator	Planting Date	Rating Date	Preceding Crop	Soil Type	Diseases Present @ Aph	Rhc	Rzm	Fus	Maggot	Rt Aphid	Comments
Moorhead Fus-N MN	Fus Nurs	Nelson Farms	5/7	6/26 to 7/15	Wheat	Medium/Heavy	N	N	N	M	N	N	Moderate Fusarium pressure, rated 4 times
Sabin Fus-S MN	Fus Nurs	Krabbenhoft & Sons Farm	5/7	7/2 to 7/25	Wheat	Medium/Light	N	N	N	L-M	N	N	Later onset of light to moderate Fusarium pressure, rated 4 times
Mhd Rhc-N MN	Rhc Nurs	Jon Hickel, ACSC	5/13	8/19	Soybean	Heavy	N	M-V	N	L	N	N	Moderate to heavy Rhizoctonia pressure
Mhd Rhc-S MN	Rhc Nurs	Jon Hickel, ACSC	5/13	7/31	Soybean	Heavy	N	M	N	L	N	N	Moderate Rhizoctonia pressure
NWROC MN	Rhc Nurs	Maureen Aubol, U of MN	5/9	8/13	Soybean	Medium/Heavy	N	M	N	N	N	N	Moderate Rhizoctonia pressure
Saginaw MI	Rhc Nurs	Linda Hanson, USDA & BSDF	5/12	8/7 to 8/8	--	--	L	V	N	N	N	N	Severe Rhizoctonia pressure
Shakopee MN	Aphanomyces	Patrick O'Boyle, KWS	5/12	8/26	--	--	M-V	L	N	N	N	N	Nice range of moderate Aphanomyces symptoms
Glyndon MN	Aphanomyces	Ryan Brady, Magno Seed	5/27	8/28	--	Light	L-M	N	N	L	N	N	Light to moderate Aphanomyces pressure
Perley MN	Aphanomyces	TD Hoff Partnership	5/7	--	Wheat	Heavy	L	L	N	N	N	N	Not rated due to low Aphanomyces pressure
Alvarado MN	Aphanomyces	Nordling Farms	5/9	--	Wheat	Heavy	L	N	N	N	N	N	Not rated due to low Aphanomyces pressure
Shakopee MN	Root Aphid	Patrick O'Boyle, KWS	--	--	--	--	NA	NA	NA	NA	NA	NA	Greenhouse trial
Moorhead MN TSC	Root Aphid	ACSC	--	--	--	--	NA	NA	NA	NA	NA	NA	Growth chamber trial
Longmont CO	Root Aphid	Ryan Brady, Magno Seed	5/6	--	--	--	NA	NA	NA	NA	NA	L	Not rated due to low root aphid pressure
Saginaw MI	Cercospora	Linda Hanson, USDA & BSDF	4/30	7/30 to 8/20	--	--	N	N	N	N	N	N	Very nice Cercospora pressure, inoculated
Randolph MN	Cercospora	Patrick O'Boyle, KWS	5/30	7/28 to 8/28	--	--	N	N	N	N	N	N	Severe Cercospora pressure, inoculated
Averill MN	Cercospora	Tang Farms	5/10	8/12 to 9/17	Wheat	Medium/Light	N	N	N	N	N	N	Severe Cercospora pressure, non-inoculated
Caledonia ND	Cercospora	Cotton Farms	5/28	8/28 to 9/30	Wheat	Medium/Light							Moderate Cercospora pressure, non-inoculated
Stephen MN	Cercospora	Brent Riopelle	4/26	8/21 to 9/25	Wheat	Heavy	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 2025

Description	Years in Trial	Years Comm.	Fungicide Seed Treatment (Damping-off)	(Rhizoctonia)	(Aphanomyces)	Insecticide (Springtails & Maggots)	Priming (Emergence)
ACSC Commercial							
BTS 8018	6	4	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8034	6	4	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8156	5	3	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8226	4	2	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8270	4	2	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8365	3	1	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8927	7	5	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 022	6	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 130	5	3	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 138	5	2	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 260	4	2	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 269	4	2	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 361	3	1	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 369	3	1	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 793	9	7	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 912	7	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Hilleshög HIL2389	5	3	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2479	3	1	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2480	3	1	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Maribo MA717	9	7	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
SX 1815	5	3	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SX 1835	3	1	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SV 231	3	1	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
BTS 8815 (CommBench)	8	6	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 803 (CommBench)	8	5	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
AP CK MOD RES RR#7	7	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
AP CK MOD SUS RR#8	6	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
ACSC Experimental							
BTS 8440	2	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8457	2	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8509	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8513	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8520	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8531	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8555	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8580	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
BTS 8598	1	NC	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 364	3	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 470	2	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 471	2	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 580	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 581	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 583	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 584	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 591	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Crystal 594	1	NC	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
Hilleshög HIL2493	2	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2494	2	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2532	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2533	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2534	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
Hilleshög HIL2535	1	NC	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
SV 251	1	NC	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SV 254	1	NC	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SV 255	1	NC	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SV 256	1	NC	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SV 345	2	NC	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
SV 347	2	NC	Apron XL/Thiram	Zeltera	Tach 45	NipsIt	Xbeet ®
BTS 8815 (CommBench)	8	6	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
Crystal 803 (CommBench)	8	5	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®
BTS 8927 (CommBench)	7	5	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
HIL2389 (CommBench)	5	3	Apron XL/Thiram/Maxim	Vibrance	Tach 45	Cruiser	Xbeet ®
BTS 8156 (1stYearBench)	5	3	Allegiance/Thiram	Kabina	Tach 35	Poncho Beta	Ultipro
AP CK MOD RES RR#7	7	4	Allegiance/Thiram	Kabina	Tach 45	Poncho Beta	Xbeet ®

Created 2/26/2025

Table 9. 2025 Performance of Varieties - ACSC RR Official Trials 12 sites

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	LTM	Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	324.3	99	11348	103	62.57	98	2179	101	35.15	17.23	1.01	16.22	219	1403	333	74.6
BTS 8034	122	314.0	96	11001	100	58.73	92	2051	95	35.17	16.83	1.14	15.69	261	1638	350	67.5
BTS 8156	118	323.9	99	11082	100	62.42	97	2130	99	34.30	17.27	1.07	16.20	222	1601	326	69.7
BTS 8226	117	335.9	102	11373	103	66.83	104	2256	105	33.98	17.74	0.95	16.79	199	1345	305	72.5
BTS 8270	116	333.1	101	11114	101	65.80	103	2189	102	33.49	17.64	0.99	16.65	191	1459	312	65.3
BTS 8365	120	338.7	103	10770	97	67.89	106	2151	100	31.93	17.91	0.98	16.93	190	1390	317	63.8
BTS 8927 (CommBench)	115	333.0	101	11262	102	65.76	103	2215	103	33.99	17.63	0.98	16.65	205	1365	320	72.6
Crystal 022	105	336.4	102	11185	101	67.03	104	2216	103	33.44	17.80	0.98	16.82	196	1385	323	73.9
Crystal 130	110	330.8	101	11312	102	64.94	101	2213	103	34.35	17.54	1.00	16.54	202	1435	321	70.6
Crystal 138	119	331.7	101	11297	102	65.28	102	2216	103	34.18	17.59	1.00	16.59	188	1436	329	68.4
Crystal 260	104	330.7	101	11333	103	64.91	101	2219	103	34.39	17.48	0.95	16.53	192	1423	289	70.5
Crystal 269	107	333.0	101	11455	104	65.76	103	2253	105	34.53	17.74	1.09	16.65	217	1519	360	68.6
Crystal 361	111	337.2	103	11455	104	67.32	105	2282	106	34.09	17.80	0.94	16.86	188	1323	306	74.0
Crystal 369	109	326.6	99	11445	104	63.41	99	2214	103	35.20	17.43	1.10	16.33	225	1521	366	68.1
Crystal 793	112	328.2	100	11427	103	64.00	100	2220	103	34.97	17.40	0.99	16.41	215	1389	317	74.5
Crystal 912	102	311.9	95	11742	106	57.95	90	2174	101	37.79	16.66	1.07	15.59	286	1364	363	74.3
Hilleshög HIL2389 (CommBench)	103	326.0	99	10945	99	63.20	99	2116	98	33.70	17.31	1.01	16.30	194	1494	317	67.5
Hilleshög HIL2479	101	324.7	99	10751	97	62.71	98	2067	96	33.24	17.30	1.06	16.24	265	1418	351	72.1
Hilleshög HIL2480	113	319.8	97	10818	98	60.90	95	2052	95	33.98	17.19	1.20	15.99	288	1508	421	69.3
Maribo MA717	121	316.2	96	11043	100	59.56	93	2065	96	35.19	16.89	1.08	15.81	263	1503	342	64.1
SX 1815	108	324.6	99	10925	99	62.66	98	2097	98	33.85	17.25	1.02	16.23	210	1514	314	64.8
SX 1835	114	317.2	97	11469	104	59.93	93	2160	100	36.25	16.96	1.10	15.86	233	1541	355	72.3
SV 231	123	319.5	97	11491	104	60.80	95	2179	101	36.07	17.02	1.04	15.98	221	1510	324	75.2
BTS 8815 (CommBench)	124	328.2	100	10786	98	63.99	100	2095	97	33.02	17.47	1.06	16.41	225	1570	320	71.0
Crystal 803 (CommBench)	125	327.2	100	11202	101	63.64	99	2174	101	34.32	17.36	1.00	16.36	202	1436	316	74.7
AP CK MOD RES RR#7	126	312.9	95	11738	106	58.36	91	2178	101	37.69	16.69	1.04	15.65	266	1375	343	76.8
AP CK MOD SUS RR#8	127	334.7	102	11479	104	66.39	103	2269	106	34.46	17.70	0.97	16.73	187	1393	311	73.3
Experimental Trial (Comm status)																	
BTS 8440	222	338.7	103	11469	104	67.86	106	2290	107	34.01	17.86	0.92	16.94	172	1362	281	73.5
BTS 8457	202	333.0	101	11344	103	65.74	102	2228	104	34.30	17.54	0.90	16.65	203	1244	282	72.6
BTS 8509	211	334.5	102	11354	103	66.31	103	2244	104	34.06	17.63	0.90	16.73	184	1315	276	70.9
BTS 8513	210	325.4	99	10890	99	62.94	98	2101	98	33.60	17.46	1.20	16.26	219	1636	406	68.8
BTS 8520	223	326.2	99	11605	105	63.27	99	2242	104	35.73	17.32	1.00	16.32	205	1415	320	69.7
BTS 8531	228	323.3	98	11585	105	62.17	97	2217	103	36.08	17.20	1.03	16.17	222	1446	328	74.2
BTS 8555	206	329.8	100	10966	99	64.59	101	2136	99	33.46	17.47	0.98	16.50	186	1364	321	71.5
BTS 8580	208	332.0	101	10454	95	65.37	102	2054	96	31.60	17.60	1.00	16.60	199	1394	324	74.6
BTS 8598	214	337.4	103	11378	103	67.37	105	2262	105	33.90	17.83	0.96	16.87	182	1364	306	72.1
Crystal 364	226	317.6	97	11497	104	60.09	94	2162	101	36.45	16.96	1.07	15.89	248	1561	317	77.6
Crystal 470	213	325.9	99	11623	105	63.15	98	2247	105	35.77	17.29	0.98	16.31	200	1384	313	73.1
Crystal 471	217	335.9	102	11370	103	66.82	104	2251	105	34.05	17.74	0.95	16.79	188	1335	303	69.2
Crystal 580	224	328.5	100	11366	103	64.13	100	2208	103	34.79	17.44	1.01	16.43	200	1441	318	71.2
Crystal 581	227	338.6	103	11395	103	67.84	106	2270	106	33.88	17.89	0.96	16.93	183	1367	304	66.4
Crystal 583	201	325.3	99	11344	103	62.90	98	2185	102	35.06	17.22	0.95	16.27	229	1336	293	73.9
Crystal 584	204	339.1	103	11278	102	68.00	106	2254	105	33.39	17.94	0.98	16.96	183	1393	316	72.6
Crystal 591	209	339.3	103	11529	104	68.09	106	2307	107	34.09	17.93	0.96	16.97	183	1349	308	73.6
Crystal 594	203	336.2	102	11662	106	66.92	104	2312	108	34.88	17.74	0.93	16.81	187	1329	290	72.3
Hilleshög HIL2493	220	317.7	97	11486	104	60.14	94	2164	101	36.34	16.95	1.06	15.89	232	1518	326	73.0
Hilleshög HIL2494	229	316.1	96	11200	101	59.57	93	2101	98	35.61	16.94	1.13	15.81	222	1588	361	72.4
Hilleshög HIL2532	216	322.8	98	10615	96	61.98	97	2030	94	33.05	17.20	1.05	16.15	207	1491	336	65.7
Hilleshög HIL2533	218	317.9	97	11464	104	60.22	94	2159	100	36.28	16.94	1.04	15.90	205	1513	321	72.8
Hilleshög HIL2534	221	320.5	98	10674	97	61.15	95	2026	94	33.53	17.16	1.13	16.03	217	1569	373	65.7
Hilleshög HIL2535	205	326.4	99	11086	100	63.33	99	2145	100	34.08	17.33	1.00	16.33	183	1476	311	68.7
SV 251	207	326.3	99	11519	104	63.31	99	2226	104	35.46	17.37	1.05	16.32	195	1581	311	71.1
SV 254	212	319.6	97	11178	101	60.82	95	2118	98	35.15	17.06	1.08	15.98	227	1556	329	68.6
SV 255	215	317.6	97	11433	103	60.10	94	2155	100	36.16	16.94	1.06	15.88	228	1527	323	71.4
SV 256	225	319.1	97	11162	101	60.65	95	2112	98	35.18	17.02	1.06	15.96	216	1538	327	67.5
SV 345	219	318.4	97	11366	103	60.41	94	2147	100	35.87	17.00	1.07	15.93	223	1559	327	69.5
SV 347	230	325.8	99	10913	99	63.12	98	2101	98	33.74	17.36	1.06	16.30	202	1538	330	69.1
BTS 8815 (CommBench)	231	325.6	99	10870	98	63.06	98	2095	97	33.54	17.35	1.06	16.29	224	1565	317	68.6
Crystal 803 (CommBench)	232	328.8	100	11188	101	64.24	100	2183	102	34.09	17.44	1.00	16.45	191	1443	315	76.5
BTS 8927 (CommBench)	233	335.4	102	11249	102	66.64	104	2231	104	33.64	17.71	0.95	16.76	184	1355	299	75.1
HIL2389 (CommBench)	234	324.6	99	10889	99	62.65	98	2091	97	33.77	17.27	1.04	16.23	210	1518	318	66.8
BTS 8156 (1stYearBench)	235	325.1	99	10816	98	62.84	98	2085	97	33.39	17.32	1.05	16.27	220	1605	303	69.5
AP CK MOD RES RR#7	236	311.9	95	11706	106	58.00	90	2169	101	37.69	16.66	1.07	15.59	263	1400	350	74.5
Comm Benchmark Mean		328.6		11049		64.15		2150		33.76	17.44	1.01		207	1466	318	71.5
Comm Trial Mean		326.7		11231		63.44		2171		34.55	17.36	1.03		220	1454	332	70.7
Coeff. of Var. (%)		2.6		5.7		4.9		7.0		5.4	2.2	7.8		16.8	4.6	13.9	13.1
Mean LSD (0.05)		5.0		326		1.86		84		0.91	0.23	0.04		23	44	24	3.0
Mean LSD (0.01)		6.6		429		2.44		111		1.19	0.31	0.06		30	57	32	4.0
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from 12 sites

Created 10/08/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs.

Trial # = 25ACSExp

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 10. 2025 Performance of Varieties - ACSC RR Official Trials
Casselton ND

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	315.7	98	12711	104	59.37	96	2388	101	40.30	16.72	0.94	15.78	269	1258	293	81.8
BTS 8034	122	316.0	98	12901	105	59.48	96	2432	103	40.79	16.81	1.01	15.80	285	1381	309	71.6
BTS 8156	118	328.1	102	13004	106	63.98	103	2536	108	39.61	17.41	1.00	16.41	235	1384	321	70.7
BTS 8226	117	336.7	104	13632	111	67.13	108	2719	116	40.43	17.70	0.87	16.83	210	1194	279	74.1
BTS 8270	116	327.5	102	12852	105	63.74	103	2502	106	39.39	17.29	0.90	16.39	177	1287	294	69.6
BTS 8365	120	331.7	103	12534	102	65.31	106	2468	105	37.79	17.52	0.93	16.59	249	1240	299	67.2
BTS 8927 (CommBench)	115	321.6	100	12849	105	61.57	100	2459	105	39.90	17.07	0.99	16.08	308	1221	332	78.3
Crystal 022	105	331.8	103	13173	107	65.32	106	2589	110	39.74	17.52	0.94	16.58	250	1278	300	78.9
Crystal 130	110	325.5	101	12933	105	63.01	102	2504	106	39.69	17.21	0.93	16.28	233	1269	301	75.2
Crystal 138	119	328.0	102	13318	109	63.94	103	2596	110	40.55	17.37	0.98	16.39	234	1321	321	71.8
Crystal 260	104	319.0	99	12678	103	60.60	98	2408	102	39.75	16.89	0.93	15.96	242	1283	289	71.1
Crystal 269	107	324.6	101	13469	110	62.68	101	2605	111	41.37	17.33	1.09	16.24	265	1394	376	76.3
Crystal 361	111	329.1	102	13378	109	64.33	104	2616	111	40.61	17.34	0.88	16.46	218	1183	289	80.4
Crystal 369	109	317.1	98	13061	107	59.91	97	2467	105	41.19	16.90	1.05	15.85	295	1334	350	69.4
Crystal 793	112	328.0	102	13661	111	63.92	103	2661	113	41.62	17.25	0.86	16.39	278	1119	264	76.2
Crystal 912	102	301.2	93	13410	109	54.02	87	2403	102	44.55	16.10	1.04	15.06	370	1169	356	80.1
Hilleshög HIL2389 (CommBench)	103	320.8	99	12203	100	61.26	99	2331	99	38.04	16.94	0.90	16.04	215	1237	285	72.7
Hilleshög HIL2479	101	315.2	98	11211	91	59.18	96	2106	90	35.63	16.91	1.15	15.76	313	1285	433	72.6
Hilleshög HIL2480	113	307.3	95	10633	87	56.28	91	1952	83	34.56	16.57	1.20	15.37	391	1296	443	73.1
Maribo MA717	121	305.2	95	11033	90	55.49	90	2005	85	36.22	16.34	1.08	15.26	354	1217	382	72.5
SX 1815	108	320.9	100	12493	102	61.28	99	2383	101	39.02	16.94	0.90	16.04	230	1207	294	69.6
SX 1835	114	309.5	96	11403	93	57.08	92	2109	90	36.71	16.48	1.01	15.47	276	1291	340	79.0
SV 231	123	315.4	98	12142	99	59.27	96	2279	97	38.60	16.77	1.00	15.77	266	1339	323	74.1
BTS 8815 (CommBench)	124	324.6	101	11849	97	62.68	101	2291	97	36.45	17.22	0.99	16.23	263	1302	323	76.0
Crystal 803 (CommBench)	125	322.8	100	12142	99	62.00	100	2331	99	37.54	17.14	1.00	16.14	269	1286	337	82.3
AP CK MOD RES RR#7	126	302.2	94	13335	109	54.38	88	2396	102	44.19	16.13	1.02	15.11	383	1148	346	75.8
AP CK MOD SUS RR#8	127	331.4	103	13034	106	65.17	105	2565	109	39.31	17.46	0.89	16.57	210	1286	274	79.4
Experimental Trial (Comm status)																	
BTS 8440	222	331.8	103	12778	104	65.31	106	2504	106	38.91	17.47	0.91	16.55	190	1296	318	72.6
BTS 8457	202	316.4	98	12443	101	59.67	96	2340	99	39.66	16.74	0.95	15.79	249	1247	346	75.9
BTS 8509	211	322.7	100	12352	101	62.01	100	2358	100	38.44	17.02	0.88	16.14	207	1317	281	70.8
BTS 8513	210	319.2	99	12286	100	60.69	98	2329	99	38.71	17.19	1.24	15.95	198	1630	495	74.9
BTS 8520	223	319.8	99	12426	101	60.89	98	2361	100	38.94	17.00	1.02	15.98	232	1359	374	68.1
BTS 8531	228	312.4	97	12561	102	58.19	94	2338	99	40.17	16.67	1.06	15.62	209	1442	395	76.2
BTS 8555	206	324.5	101	12618	103	62.63	101	2426	103	38.83	17.23	0.98	16.25	185	1346	360	69.4
BTS 8580	208	324.8	101	11554	94	62.76	101	2230	95	35.55	17.23	0.99	16.24	205	1419	347	73.6
BTS 8598	214	327.0	101	12552	102	63.56	103	2434	103	38.71	17.27	0.95	16.31	217	1354	336	75.8
Crystal 364	226	306.5	95	12877	105	56.03	91	2348	100	42.12	16.36	1.03	15.33	259	1481	342	77.7
Crystal 470	213	320.0	99	13216	108	60.99	99	2560	109	40.72	16.97	0.98	15.99	231	1370	341	74.1
Crystal 471	217	331.4	103	12766	104	65.16	105	2499	106	38.61	17.46	0.90	16.56	175	1323	314	73.2
Crystal 580	224	315.0	98	11813	96	59.16	96	2204	94	37.71	16.78	1.02	15.76	207	1491	342	72.7
Crystal 581	227	326.9	101	13139	107	63.52	103	2530	108	40.70	17.32	0.99	16.33	197	1453	339	66.2
Crystal 583	201	314.7	98	13038	106	59.04	95	2436	104	41.69	16.64	0.93	15.71	243	1360	307	80.7
Crystal 584	204	339.3	105	12527	102	68.09	110	2516	107	36.86	17.85	0.88	16.98	179	1285	292	72.5
Crystal 591	209	333.3	103	12425	101	65.86	106	2440	104	37.49	17.57	0.90	16.67	186	1291	314	77.9
Crystal 594	203	327.1	101	13075	107	63.59	103	2534	108	40.21	17.33	1.00	16.33	227	1384	353	75.5
Hilleshög HIL2493	220	305.6	95	11375	93	55.70	90	2060	88	37.59	16.34	1.07	15.27	247	1564	360	74.9
Hilleshög HIL2494	229	298.7	93	11095	90	53.19	86	1977	84	37.24	16.02	1.11	14.91	258	1492	404	73.4
Hilleshög HIL2532	216	320.4	99	11986	98	61.12	99	2275	97	37.78	16.94	0.95	15.99	195	1371	330	73.5
Hilleshög HIL2533	218	289.1	90	11500	94	49.67	80	1963	83	40.14	15.54	1.09	14.45	268	1543	358	80.4
Hilleshög HIL2534	221	312.3	97	11158	91	58.17	94	2074	88	35.82	16.72	1.12	15.61	230	1505	406	63.2
Hilleshög HIL2535	205	314.1	97	11476	94	58.83	95	2135	91	36.82	16.65	0.95	15.70	198	1405	314	73.1
SV 251	207	317.8	99	12673	103	60.17	97	2395	102	39.96	16.89	1.01	15.88	202	1451	356	80.5
SV 254	212	307.5	95	11105	91	56.38	91	2026	86	36.37	16.52	1.16	15.36	321	1624	386	75.0
SV 255	215	313.0	97	11726	96	58.43	94	2191	93	37.60	16.64	1.02	15.62	229	1543	337	78.4
SV 256	225	302.8	94	10519	86	54.69	88	1915	81	34.50	16.16	1.01	15.15	225	1517	328	76.3
SV 345	219	306.9	95	11262	92	56.18	91	2060	88	36.79	16.46	1.13	15.33	251	1632	382	74.4
SV 347	230	311.8	97	11720	96	57.99	94	2175	92	37.57	16.63	1.04	15.60	199	1527	363	73.7
BTS 8815 (CommBench)	231	331.9	103	12312	100	65.35	106	2420	103	37.15	17.50	0.91	16.59	198	1365	286	70.1
Crystal 803 (CommBench)	232	313.8	97	12156	99	58.70	95	2303	98	38.18	16.76	1.07	15.69	218	1551	360	78.2
BTS 8927 (CommBench)	233	334.3	104	12584	103	66.21	107	2490	106	37.51	17.67	0.95	16.72	218	1351	326	74.4
HIL2389 (CommBench)	234	309.9	96	11990	98	57.25	93	2199	93	39.09	16.44	0.95	15.48	223	1435	305	78.1
BTS 8156 (1stYearBench)	235	322.7	100	12163	99	62.00	100	2330	99	37.81	17.18	1.05	16.13	205	1611	346	77.3
AP CK MOD RES RR#7	236	305.4	95	12643	103	55.61	90	2299	98	41.60	16.31	1.05	15.26	269	1433	361	81.9
Comm Benchmark Mean		322.5		12261		61.88		2353		37.98	17.09	0.97		264	1262	319	77.3
Comm Trial Mean		320.6		12631		61.20		2411		39.39	17.01	0.98		270	1267	324	74.8
Coeff. of Var. (%)		2.6		5.3		5.0		6.7		4.8	2.3	7.0		17.2	5.5	12.3	11.8
Mean LSD (0.05)		7.6		620		2.81		150		1.70	0.35	0.06		43	66	37	7.6
Mean LSD (0.01)		10.0		817		3.70		198		2.24	0.47	0.08		57	87	49	10.0
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Casselton ND — Created 10/07/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258301

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 11. 2025 Performance of Varieties - ACSC RR Official Trials
Averill MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	304.8	100	9266	101	55.34	100	1693	101	30.33	16.52	1.29	15.23	264	1565	485	68.0
BTS 8034	122	282.3	92	8777	96	47.00	85	1452	87	31.26	15.60	1.49	14.11	402	1908	496	61.2
BTS 8156	118	302.3	99	8840	96	54.42	98	1598	96	29.32	16.49	1.37	15.12	325	1876	447	72.2
BTS 8226	117	320.0	105	9208	100	60.97	110	1752	105	28.74	17.20	1.20	16.00	243	1507	439	64.0
BTS 8270	116	317.3	104	8703	95	59.98	108	1640	98	27.31	17.06	1.19	15.87	244	1560	421	55.0
BTS 8365	120	320.7	105	8098	88	61.22	110	1542	92	25.31	17.22	1.19	16.03	238	1543	424	46.7
BTS 8927 (CommBench)	115	318.3	104	9378	102	60.34	109	1773	106	29.59	17.10	1.18	15.92	244	1470	436	74.6
Crystal 022	105	317.6	104	9089	99	60.06	108	1711	102	28.44	17.11	1.24	15.87	245	1539	459	71.0
Crystal 130	110	317.8	104	9358	102	60.14	108	1755	105	29.68	17.12	1.23	15.89	221	1604	447	60.9
Crystal 138	119	308.9	101	9154	100	56.85	102	1682	101	29.70	16.70	1.25	15.45	241	1605	457	60.3
Crystal 260	104	317.5	104	9302	101	60.04	108	1746	104	29.35	17.10	1.22	15.88	262	1564	437	65.5
Crystal 269	107	313.1	103	9274	101	58.41	105	1734	104	29.59	17.03	1.38	15.65	253	1733	518	58.2
Crystal 361	111	327.4	107	9250	101	63.69	115	1792	107	28.16	17.47	1.10	16.37	220	1396	400	69.6
Crystal 369	109	307.9	101	8885	97	56.47	102	1618	97	28.85	16.69	1.29	15.40	255	1689	461	48.3
Crystal 793	112	318.0	104	9390	102	60.21	108	1770	106	29.90	17.06	1.16	15.90	241	1519	409	70.3
Crystal 912	102	293.8	96	9932	108	51.29	92	1736	104	33.62	16.01	1.32	14.69	326	1565	488	72.5
Hilleshög HIL2389 (CommBench)	103	303.9	100	9354	102	55.00	99	1700	102	30.74	16.48	1.28	15.20	264	1778	426	58.6
Hilleshög HIL2479	101	305.2	100	8694	95	55.49	100	1597	95	28.37	16.63	1.38	15.25	382	1621	495	55.6
Hilleshög HIL2480	113	299.2	98	8701	95	53.28	96	1555	93	29.19	16.45	1.49	14.96	363	1785	543	58.1
Maribo MA717	121	294.8	97	8826	96	51.64	93	1523	91	30.15	16.02	1.28	14.74	342	1670	419	59.5
SX 1815	108	290.8	95	9070	99	50.17	90	1575	94	31.06	15.94	1.40	14.54	322	1832	482	57.3
SX 1835	114	299.8	98	9904	108	53.50	96	1775	106	32.82	16.37	1.38	14.99	307	1766	486	68.8
SV 231	123	297.5	97	9850	107	52.65	95	1744	104	33.12	16.15	1.28	14.87	298	1676	434	76.3
BTS 8815 (CommBench)	124	299.2	98	8949	97	53.28	96	1599	96	30.04	16.27	1.31	14.96	316	1796	424	58.8
Crystal 803 (CommBench)	125	299.9	98	9053	99	53.52	96	1618	97	30.01	16.27	1.28	14.99	297	1728	424	71.0
AP CK MOD RES RR#7	126	303.1	99	9639	105	54.70	98	1746	104	31.83	16.33	1.17	15.16	271	1504	411	73.3
AP CK MOD SUS RR#8	127	315.3	103	9901	108	59.24	107	1858	111	31.74	17.03	1.26	15.77	262	1600	456	78.3
Experimental Trial (Comm status)																	
BTS 8440	222	324.6	106	9190	100	62.52	113	1772	106	28.29	17.35	1.12	16.24	227	1475	384	66.2
BTS 8457	202	313.8	103	9031	98	58.60	106	1692	101	28.91	16.75	1.09	15.67	258	1310	387	61.0
BTS 8509	211	315.4	103	8632	94	59.16	107	1619	97	27.39	16.93	1.15	15.78	251	1477	397	62.4
BTS 8513	210	297.8	98	8630	94	52.81	95	1532	92	29.12	16.36	1.48	14.88	346	1805	520	57.8
BTS 8520	223	305.5	100	9117	99	55.62	100	1663	99	30.02	16.46	1.20	15.26	256	1534	415	60.9
BTS 8531	228	314.8	103	9842	107	58.96	106	1844	110	31.26	16.90	1.16	15.74	247	1470	403	70.4
BTS 8555	206	307.9	101	8881	97	56.46	102	1632	98	28.85	16.62	1.24	15.38	255	1514	443	64.7
BTS 8580	208	313.8	103	8726	95	58.59	105	1628	97	27.96	16.85	1.17	15.68	238	1462	411	74.8
BTS 8598	214	323.8	106	9227	100	62.25	112	1779	106	28.45	17.28	1.10	16.19	214	1403	392	68.2
Crystal 364	226	295.2	97	9362	102	51.89	93	1644	98	31.92	16.02	1.27	14.75	327	1701	400	73.1
Crystal 470	213	313.4	103	9146	100	58.48	105	1708	102	29.30	16.81	1.15	15.66	255	1489	385	66.7
Crystal 471	217	323.1	106	9420	103	61.97	112	1806	108	29.18	17.32	1.15	16.18	223	1506	398	70.8
Crystal 580	224	304.4	100	9245	101	55.18	99	1674	100	30.46	16.47	1.25	15.22	270	1540	449	66.1
Crystal 581	227	335.2	110	9448	103	66.36	119	1874	112	28.20	17.84	1.07	16.77	193	1415	369	58.9
Crystal 583	201	303.6	99	9214	100	54.91	99	1671	100	30.49	16.36	1.19	15.17	325	1475	396	67.1
Crystal 584	204	320.1	105	9386	102	60.89	110	1789	107	29.48	17.18	1.20	15.98	236	1473	430	69.2
Crystal 591	209	326.3	107	9516	104	63.16	114	1844	110	29.12	17.43	1.11	16.32	222	1447	385	73.7
Crystal 594	203	331.6	109	9579	104	65.07	117	1887	113	28.79	17.67	1.08	16.59	207	1381	383	67.9
Hilleshög HIL2493	220	291.6	96	9698	106	50.57	91	1687	101	33.19	15.98	1.39	14.58	335	1739	475	70.7
Hilleshög HIL2494	229	289.5	95	9549	104	49.78	90	1647	98	32.94	15.89	1.41	14.48	313	1846	476	69.2
Hilleshög HIL2532	216	293.3	96	9072	99	51.18	92	1589	95	30.78	16.10	1.43	14.67	319	1748	510	56.7
Hilleshög HIL2533	218	304.5	100	10092	110	55.24	99	1828	109	33.26	16.52	1.30	15.22	275	1680	443	70.8
Hilleshög HIL2534	221	280.1	92	8522	93	46.39	84	1411	84	30.43	15.54	1.54	14.00	338	1820	564	65.0
Hilleshög HIL2535	205	307.6	101	9301	101	56.36	101	1709	102	30.26	16.66	1.28	15.38	250	1785	412	58.8
SV 251	207	302.4	99	9875	108	54.46	98	1777	106	32.65	16.44	1.32	15.12	288	1760	435	66.8
SV 254	212	301.4	99	9664	105	54.11	97	1744	104	32.23	16.29	1.26	15.03	276	1660	403	65.3
SV 255	215	285.5	94	9431	103	48.35	87	1599	96	33.10	15.61	1.35	14.26	390	1665	447	68.4
SV 256	225	302.5	99	8968	98	54.53	98	1613	96	29.72	16.41	1.28	15.13	279	1798	396	62.3
SV 345	219	287.4	94	9280	101	49.03	88	1586	95	32.42	15.68	1.33	14.35	365	1674	433	59.5
SV 347	230	305.3	100	9395	102	55.53	100	1713	102	30.76	16.54	1.27	15.27	257	1840	392	60.3
BTS 8815 (CommBench)	231	293.7	96	8831	96	51.32	92	1549	93	30.08	16.06	1.39	14.66	336	1814	450	67.5
Crystal 803 (CommBench)	232	310.2	102	9195	100	57.28	103	1702	102	29.77	16.67	1.16	15.51	230	1516	397	76.3
BTS 8927 (CommBench)	233	316.1	104	9387	102	59.44	107	1765	106	29.72	16.97	1.16	15.81	242	1495	399	74.3
HIL2389 (CommBench)	234	301.3	99	9322	102	54.09	97	1674	100	30.82	16.43	1.34	15.09	304	1761	452	65.8
BTS 8156 (1stYearBench)	235	306.1	100	8943	97	55.83	101	1632	98	29.14	16.69	1.37	15.32	304	1837	451	74.8
AP CK MOD RES RR#7	236	283.9	93	9552	104	47.75	86	1610	96	33.84	15.55	1.38	14.17	375	1560	497	75.3
Comm Benchmark Mean		305.3		9184		55.54		1673		30.10	16.53	1.26		280	1693	427	65.7
Comm Trial Mean		307.3		9179		56.25		1677		29.93	16.65	1.28		283	1644	453	64.2
Coeff. of Var. (%)		2.5		5.5		5.1		6.7		5.5	2.0	6.7		13.0	4.4	10.5	15.5
Mean LSD (0.05)		7.4		438		2.73		102		1.48	0.32	0.08		35	68	45	9.0
Mean LSD (0.01)		9.7		577		3.60		135		1.94	0.42	0.11		46	89	60	11.8
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Averill MN — Created 09/15/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258302

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 12. 2025 Performance of Varieties - ACSC RR Official Trials
Perley MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	341.4	98	12942	103	68.88	97	2590	101	38.27	18.11	1.04	17.07	180	1427	364	67.5
BTS 8034	122	337.6	97	12622	101	67.47	95	2529	99	37.32	17.94	1.07	16.87	152	1629	339	65.6
BTS 8156	118	343.2	99	12606	101	69.55	98	2563	100	36.69	18.22	1.06	17.16	162	1591	341	63.7
BTS 8226	117	354.4	102	12977	104	73.71	104	2709	106	36.41	18.57	0.84	17.73	131	1249	275	67.0
BTS 8270	116	349.8	101	12414	99	71.97	102	2528	99	35.98	18.44	0.96	17.48	146	1473	300	58.5
BTS 8365	120	359.5	104	12532	100	75.60	107	2634	103	34.75	18.93	0.95	17.98	135	1329	335	59.4
BTS 8927 (CommBench)	115	351.2	101	12601	101	72.51	102	2589	101	36.26	18.43	0.88	17.55	128	1377	269	69.0
Crystal 022	105	354.4	102	12544	100	73.70	104	2594	101	35.39	18.72	1.00	17.72	155	1393	348	70.3
Crystal 130	110	344.9	99	12617	101	70.18	99	2553	100	36.84	18.24	1.00	17.24	151	1418	344	65.9
Crystal 138	119	344.5	99	12609	101	70.03	99	2559	100	36.41	18.28	1.05	17.23	148	1466	372	68.6
Crystal 260	104	337.3	97	12029	96	67.36	95	2411	94	35.56	17.82	0.95	16.87	199	1467	276	66.0
Crystal 269	107	351.2	101	13095	104	72.52	102	2718	106	37.04	18.80	1.23	17.57	146	1526	495	72.2
Crystal 361	111	349.6	101	12495	100	71.93	102	2569	100	36.11	18.38	0.91	17.47	124	1339	302	75.1
Crystal 369	109	334.7	97	12266	98	66.42	94	2427	95	36.85	17.89	1.15	16.74	194	1504	425	64.8
Crystal 793	112	343.7	99	12792	102	69.73	98	2594	101	37.19	18.14	0.96	17.18	156	1337	328	71.3
Crystal 912	102	329.2	95	13236	106	64.37	91	2587	101	40.47	17.54	1.09	16.45	221	1362	400	70.8
Hilleshög HIL2389 (CommBench)	103	337.0	97	12217	97	67.24	95	2444	96	36.47	17.92	1.08	16.84	139	1555	370	64.8
Hilleshög HIL2479	101	332.4	96	11364	91	65.57	93	2253	88	33.89	17.67	1.04	16.63	191	1390	363	70.2
Hilleshög HIL2480	113	345.1	100	11949	95	70.25	99	2438	95	34.68	18.41	1.16	17.25	182	1501	434	71.0
Maribo MA717	121	329.7	95	12125	97	64.54	91	2366	92	36.66	17.62	1.13	16.49	199	1574	387	60.9
SX 1815	108	349.8	101	12434	99	72.01	102	2547	100	35.63	18.41	0.91	17.50	135	1503	259	64.1
SX 1835	114	329.9	95	12598	101	64.63	91	2475	97	37.97	17.59	1.10	16.49	160	1550	378	65.0
SV 231	123	330.3	95	12801	102	64.78	91	2520	98	38.53	17.53	1.01	16.52	166	1488	325	72.2
BTS 8815 (CommBench)	124	354.1	102	12445	99	73.59	104	2584	101	35.14	18.71	1.00	17.71	152	1529	316	71.9
Crystal 803 (CommBench)	125	344.4	99	12869	103	69.99	99	2617	102	37.24	18.21	1.00	17.21	156	1451	329	67.3
AP CK MOD RES RR#7	126	333.1	96	13191	105	65.79	93	2613	102	39.46	17.65	0.99	16.66	165	1418	331	71.0
AP CK MOD SUS RR#8	127	338.8	98	13504	108	67.93	96	2702	106	39.87	17.91	0.96	16.95	151	1379	326	69.7
Experimental Trial (Comm status)																	
BTS 8440	222	356.6	103	12316	98	74.48	105	2579	101	34.68	18.73	0.88	17.84	109	1350	257	63.0
BTS 8457	202	349.1	101	13329	106	71.73	101	2733	107	38.31	18.32	0.86	17.46	135	1225	262	63.4
BTS 8509	211	354.5	102	12485	100	73.69	104	2590	101	35.30	18.61	0.88	17.73	129	1297	261	71.3
BTS 8513	210	337.4	97	12415	99	67.44	95	2474	97	36.69	18.11	1.27	16.84	154	1592	458	68.6
BTS 8520	223	344.4	99	12695	101	70.01	99	2584	101	37.05	18.15	0.94	17.22	134	1312	293	63.8
BTS 8531	228	335.2	97	13862	111	66.63	94	2756	108	41.36	17.74	0.98	16.76	152	1384	298	77.1
BTS 8555	206	341.3	98	12074	96	68.85	97	2438	95	35.41	18.03	0.97	17.06	143	1368	298	61.6
BTS 8580	208	346.5	100	11262	90	70.78	100	2297	90	32.65	18.31	1.00	17.31	145	1316	331	77.7
BTS 8598	214	360.5	104	13094	104	75.93	107	2753	108	36.37	18.91	0.87	18.03	125	1272	261	65.4
Crystal 364	226	329.2	95	12954	103	64.44	91	2531	99	39.42	17.52	1.07	16.45	167	1570	315	83.0
Crystal 470	213	344.4	99	13173	105	70.02	99	2668	104	38.35	18.14	0.94	17.21	128	1331	285	63.7
Crystal 471	217	355.0	102	11823	94	73.89	104	2453	96	33.63	18.63	0.88	17.74	116	1351	252	61.0
Crystal 580	224	346.1	100	12801	102	70.62	100	2600	102	36.99	18.30	1.01	17.29	145	1401	315	61.8
Crystal 581	227	357.0	103	12396	99	74.60	105	2580	101	34.92	18.79	0.95	17.84	124	1385	280	58.9
Crystal 583	201	344.3	99	13106	105	69.98	99	2659	104	38.19	18.13	0.92	17.22	147	1361	260	68.1
Crystal 584	204	355.6	103	12669	101	74.10	105	2627	103	35.74	18.76	0.99	17.77	116	1423	306	64.2
Crystal 591	209	351.4	101	13555	108	72.57	102	2798	109	38.63	18.50	0.93	17.57	147	1260	294	71.8
Crystal 594	203	355.2	102	12637	101	73.97	104	2626	103	35.79	18.67	0.92	17.75	123	1319	275	70.0
Hilleshög HIL2493	220	334.0	96	13739	110	66.17	93	2724	106	41.24	17.72	1.03	16.69	152	1423	326	69.6
Hilleshög HIL2494	229	340.5	98	13322	106	68.55	97	2678	105	39.11	18.01	1.00	17.00	116	1496	297	74.3
Hilleshög HIL2532	216	342.5	99	11325	90	69.33	98	2299	90	33.17	18.16	1.04	17.12	137	1531	313	62.1
Hilleshög HIL2533	218	325.5	94	12263	98	63.07	89	2376	93	37.81	17.33	1.07	16.26	160	1533	322	63.2
Hilleshög HIL2534	221	345.3	100	12067	96	70.33	99	2449	96	34.98	18.32	1.07	17.25	121	1573	331	65.5
Hilleshög HIL2535	205	344.4	99	12391	99	70.02	99	2524	99	36.12	18.17	0.95	17.23	133	1419	278	66.6
SV 251	207	339.0	98	12513	100	68.03	96	2516	98	36.79	18.05	1.12	16.94	144	1607	342	66.2
SV 254	212	339.8	98	11831	94	68.29	96	2375	93	35.13	18.01	1.03	16.97	160	1574	282	55.2
SV 255	215	335.3	97	12799	102	66.69	94	2534	99	38.34	17.84	1.10	16.74	166	1564	327	64.1
SV 256	225	336.9	97	12544	100	67.26	95	2492	97	37.38	17.86	1.03	16.82	161	1374	332	66.8
SV 345	219	329.3	95	12599	101	64.47	91	2467	96	38.17	17.51	1.06	16.45	136	1515	331	67.6
SV 347	230	340.7	98	11560	92	68.66	97	2323	91	34.05	18.06	1.04	17.02	141	1489	319	61.8
BTS 8815 (CommBench)	231	339.3	98	12048	96	68.12	96	2422	95	35.49	18.02	1.06	16.95	138	1488	338	71.2
Crystal 803 (CommBench)	232	350.3	101	12714	101	72.17	102	2623	103	36.38	18.48	0.97	17.51	130	1418	291	74.3
BTS 8927 (CommBench)	233	348.8	101	12856	103	71.59	101	2627	103	37.15	18.36	0.93	17.44	139	1306	285	69.6
HIL2389 (CommBench)	234	348.4	100	12514	100	71.45	101	2562	100	36.09	18.41	1.00	17.41	131	1461	301	67.1
BTS 8156 (1stYearBench)	235	337.4	97	11818	94	67.44	95	2356	92	35.26	17.86	1.00	16.86	145	1598	259	57.1
AP CK MOD RES RR#7	236	329.1	95	13174	105	64.38	91	2576	101	40.13	17.41	0.96	16.45	172	1322	295	65.3
Comm Benchmark Mean		346.7		12533		70.83		2559		36.28	18.32	0.99		144	1478	321	68.2
Comm Trial Mean		342.6		12588		69.34		2545		36.78	18.15	1.02		160	1453	346	67.6
Coeff. of Var. (%)		2.6		6.5		4.8		7.2		6.6	2.2	9.4		21.4	5.5	17.4	16.9
Mean LSD (0.05)		8.4		688		3.09		160		2.07	0.36	0.09		32	77	56	10.0
Mean LSD (0.01)		11.0		906		4.07		211		2.73	0.48	0.12		43	101	74	13.2
Sig Lvl		**		**		**		**		**	**	**		**	**	**	ns

2025 Data from Perley MN — Created 10/07/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258303

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 13. 2025 Performance of Varieties - ACSC RR Official Trials
Ada MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	310.0	98	9872	105	57.28	97	1826	103	31.82	16.49	0.99	15.50	207	1184	374	79.6
BTS 8034	122	303.4	96	9631	102	54.81	92	1738	98	31.58	16.28	1.11	15.17	281	1472	368	67.8
BTS 8156	118	322.2	102	9753	103	61.79	104	1874	105	30.17	17.12	1.00	16.12	228	1420	317	68.2
BTS 8226	117	325.4	103	9968	106	62.96	106	1925	108	30.67	17.16	0.89	16.27	178	1162	316	77.9
BTS 8270	116	317.9	101	10272	109	60.18	102	1939	109	32.39	16.87	0.98	15.89	188	1222	364	73.4
BTS 8365	120	332.8	106	9914	105	65.69	111	1959	110	29.83	17.49	0.85	16.64	161	1161	293	69.6
BTS 8927 (CommBench)	115	320.2	102	9654	102	61.03	103	1838	103	30.22	16.96	0.95	16.01	179	1160	362	74.7
Crystal 022	105	323.0	102	9639	102	62.09	105	1852	104	30.02	17.06	0.91	16.15	172	1167	333	77.0
Crystal 130	110	318.3	101	10109	107	60.35	102	1903	107	31.63	16.84	0.92	15.92	196	1231	317	76.2
Crystal 138	119	318.7	101	10239	108	60.48	102	1939	109	32.00	16.84	0.90	15.94	179	1157	326	69.0
Crystal 260	104	324.4	103	10117	107	62.59	106	1957	110	31.13	17.07	0.85	16.22	155	1196	283	74.9
Crystal 269	107	317.6	101	10316	109	60.07	101	1948	109	32.32	16.89	1.01	15.88	215	1262	370	74.3
Crystal 361	111	318.1	101	9886	105	60.27	102	1879	106	31.19	16.85	0.94	15.91	197	1114	360	79.0
Crystal 369	109	312.0	99	10246	108	58.00	98	1900	107	32.87	16.65	1.05	15.60	213	1273	401	74.8
Crystal 793	112	314.3	100	9835	104	58.84	99	1846	104	31.38	16.65	0.93	15.72	189	1179	341	80.8
Crystal 912	102	287.9	91	9669	102	49.09	83	1655	93	33.46	15.48	1.08	14.40	293	1150	426	74.7
Hilleshög HIL2389 (CommBench)	103	311.5	99	9065	96	57.83	98	1695	95	29.04	16.62	1.05	15.57	203	1210	415	71.4
Hilleshög HIL2479	101	310.4	98	9808	104	57.42	97	1808	102	31.75	16.55	1.02	15.53	261	1145	392	75.4
Hilleshög HIL2480	113	311.4	99	9993	106	57.79	98	1853	104	32.27	16.74	1.16	15.58	269	1254	468	73.2
Maribo MA717	121	299.1	95	10080	107	53.22	90	1787	100	34.05	16.07	1.11	14.96	289	1246	423	66.1
SX 1815	108	317.7	101	9106	96	60.11	101	1724	97	28.80	16.88	1.00	15.88	183	1239	376	62.9
SX 1835	114	302.8	96	10148	107	54.60	92	1840	103	33.22	16.19	1.05	15.14	231	1307	382	74.8
SV 231	123	301.5	96	9882	105	54.14	91	1772	100	32.65	16.16	1.09	15.07	237	1259	422	78.0
BTS 8815 (CommBench)	124	314.3	100	9212	98	58.84	99	1728	97	29.32	16.75	1.03	15.72	227	1338	363	78.9
Crystal 803 (CommBench)	125	315.6	100	9843	104	59.33	100	1857	104	31.05	16.72	0.94	15.78	216	1193	332	75.8
AP CK MOD RES RR#7	126	290.0	92	9865	104	49.88	84	1699	95	33.79	15.53	1.03	14.50	264	1116	406	78.8
AP CK MOD SUS RR#8	127	325.0	103	9878	105	62.82	106	1907	107	30.55	17.19	0.94	16.25	172	1177	348	81.5
Experimental Trial (Comm status)																	
BTS 8440	222	325.0	103	10371	110	62.73	106	2012	113	31.85	17.15	0.90	16.25	161	1216	299	83.1
BTS 8457	202	319.5	101	10181	108	60.74	102	1942	109	31.84	16.87	0.89	15.98	171	1122	313	82.7
BTS 8509	211	317.2	101	9805	104	59.92	101	1859	104	30.90	16.81	0.94	15.87	166	1167	346	75.9
BTS 8513	210	314.4	100	10006	106	58.90	99	1881	106	31.87	16.85	1.12	15.73	167	1367	413	76.4
BTS 8520	223	312.0	99	10418	110	58.03	98	1940	109	33.32	16.65	1.06	15.60	204	1325	372	78.2
BTS 8531	228	313.7	99	9841	104	58.67	99	1844	104	31.31	16.68	1.01	15.68	208	1214	364	77.4
BTS 8555	206	315.7	100	9528	101	59.38	100	1796	101	30.11	16.81	1.02	15.79	158	1211	384	75.3
BTS 8580	208	316.7	100	9447	100	59.71	101	1790	101	29.78	16.82	1.01	15.81	202	1209	363	80.7
BTS 8598	214	326.5	104	10116	107	63.29	107	1968	111	30.92	17.31	0.98	16.33	167	1236	355	79.3
Crystal 364	226	301.8	96	9834	104	54.34	92	1778	100	32.54	16.16	1.07	15.09	234	1396	349	86.4
Crystal 470	213	314.7	100	10193	108	59.00	100	1917	108	32.34	16.68	0.95	15.73	184	1146	354	76.9
Crystal 471	217	327.0	104	10326	109	63.46	107	2015	113	31.50	17.24	0.88	16.36	164	1120	311	76.4
Crystal 580	224	312.6	99	9823	104	58.24	98	1836	103	31.43	16.65	1.02	15.64	195	1170	385	78.6
Crystal 581	227	323.8	103	10282	109	62.32	105	1986	112	31.74	17.17	0.96	16.21	158	1164	352	72.6
Crystal 583	201	311.1	99	9499	101	57.68	97	1771	100	30.44	16.48	0.93	15.55	176	1111	348	80.7
Crystal 584	204	317.1	101	9486	100	59.89	101	1800	101	29.92	16.87	1.01	15.86	172	1205	377	81.5
Crystal 591	209	320.9	102	10204	108	61.27	103	1957	110	31.78	17.03	0.97	16.05	180	1208	352	80.1
Crystal 594	203	309.6	98	9874	105	57.17	96	1827	103	31.90	16.40	0.91	15.48	175	1060	346	75.0
Hilleshög HIL2493	220	311.9	99	9901	105	57.99	98	1849	104	31.73	16.61	1.03	15.59	194	1290	360	79.4
Hilleshög HIL2494	229	309.5	98	9781	104	57.11	96	1810	102	31.54	16.56	1.07	15.50	191	1372	370	76.7
Hilleshög HIL2532	216	309.2	98	8996	95	57.00	96	1662	93	29.07	16.54	1.11	15.44	191	1292	423	62.4
Hilleshög HIL2533	218	310.6	98	9711	103	57.51	97	1804	101	31.22	16.54	1.03	15.52	196	1245	376	79.7
Hilleshög HIL2534	221	303.7	96	9123	97	55.01	93	1659	93	29.96	16.39	1.22	15.17	191	1402	478	65.2
Hilleshög HIL2535	205	307.9	98	8840	94	56.54	95	1628	91	28.68	16.46	1.06	15.40	191	1209	408	65.7
SV 251	207	317.1	101	10117	107	59.90	101	1917	108	31.88	16.87	1.00	15.87	163	1390	316	79.5
SV 254	212	303.1	96	9477	100	54.80	92	1721	97	31.21	16.24	1.10	15.14	208	1309	409	70.1
SV 255	215	310.1	98	9694	103	57.33	97	1799	101	31.21	16.51	1.02	15.50	194	1268	361	81.5
SV 256	225	300.9	95	9572	101	53.97	91	1726	97	31.77	16.13	1.09	15.04	209	1350	385	75.4
SV 345	219	304.8	97	9550	101	55.41	94	1741	98	31.31	16.34	1.11	15.23	220	1330	400	71.9
SV 347	230	315.9	100	8883	94	59.45	100	1677	94	28.09	16.84	1.05	15.79	162	1248	398	78.0
BTS 8815 (CommBench)	231	310.3	98	9193	97	57.39	97	1708	96	29.58	16.62	1.11	15.51	215	1383	388	77.3
Crystal 803 (CommBench)	232	313.7	99	9736	103	58.65	99	1825	103	31.02	16.65	0.97	15.68	160	1191	361	85.9
BTS 8927 (CommBench)	233	316.2	100	9632	102	59.54	100	1819	102	30.44	16.72	0.92	15.80	184	1171	322	84.4
HIL2389 (CommBench)	234	321.5	102	9213	98	61.45	104	1766	99	28.59	17.06	0.96	16.09	158	1244	343	69.7
BTS 8156 (1stYearBench)	235	315.4	100	9193	97	59.26	100	1735	98	29.07	16.84	1.07	15.77	221	1417	347	67.8
AP CK MOD RES RR#7	236	288.4	91	9595	102	49.46	83	1652	93	33.29	15.46	1.04	14.43	257	1153	381	83.4
Comm Benchmark Mean		315.4		9444		59.26		1780		29.91	16.76	0.99		206	1225	368	75.2
Comm Trial Mean		313.5		9852		58.57		1839		31.45	16.67	0.99		214	1222	366	74.4
Coeff. of Var. (%)		2.0		5.9		3.9		6.6		5.7	1.7	5.2		12.5	3.6	8.5	11.6
Mean LSD (0.05)		5.8		493		2.14		110		1.43	0.26	0.05		26	41	30	7.5
Mean LSD (0.01)		7.6		650		2.82		144		1.89	0.34	0.06		34	54	39	9.9
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Ada MN — Created 09/15/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258304

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 14. 2025 Performance of Varieties - ACSC RR Official Trials
Caledonia ND

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	334.6	101	9959	105	66.36	102	1981	106	29.77	17.58	0.85	16.73	155	1337	252	95.6
BTS 8034	122	313.6	95	9278	98	58.58	90	1741	93	29.71	16.69	1.02	15.67	228	1598	287	87.8
BTS 8156	118	324.5	98	9405	99	62.61	96	1815	97	28.98	17.17	0.94	16.23	155	1602	248	90.7
BTS 8226	117	341.6	103	9904	104	68.94	106	1998	107	29.03	17.91	0.83	17.08	155	1323	234	86.9
BTS 8270	116	330.2	100	9165	97	64.75	99	1800	97	27.69	17.50	1.00	16.50	190	1550	290	85.4
BTS 8365	120	343.0	103	9451	100	69.48	106	1919	103	27.40	18.07	0.93	17.14	174	1417	282	87.2
BTS 8927 (CommBench)	115	337.8	102	9786	103	67.55	104	1951	105	29.08	17.76	0.87	16.89	159	1345	259	87.0
Crystal 022	105	343.4	104	9660	102	69.64	107	1955	105	28.05	18.05	0.87	17.18	151	1365	260	89.3
Crystal 130	110	329.1	99	9406	99	64.35	99	1841	99	28.50	17.43	0.97	16.46	177	1451	298	89.0
Crystal 138	119	331.8	100	9891	104	65.34	100	1941	104	29.96	17.52	0.92	16.60	152	1424	280	89.3
Crystal 260	104	329.5	99	9471	100	64.47	99	1852	99	28.79	17.39	0.92	16.47	160	1448	270	87.5
Crystal 269	107	329.5	99	9615	101	64.48	99	1881	101	29.20	17.50	1.04	16.46	199	1526	325	87.5
Crystal 361	111	332.3	100	9971	105	65.53	100	1966	106	29.98	17.54	0.92	16.62	190	1313	295	88.3
Crystal 369	109	329.2	99	10051	106	64.38	99	1958	105	30.65	17.51	1.04	16.47	189	1559	324	87.0
Crystal 793	112	320.4	97	9574	101	61.10	94	1828	98	30.07	16.93	0.92	16.01	176	1400	274	92.1
Crystal 912	102	315.5	95	9472	100	59.29	91	1778	95	30.03	16.72	0.94	15.78	227	1332	291	89.0
Hilleshög HIL2389 (CommBench)	103	332.9	100	9474	100	65.73	101	1867	100	28.52	17.51	0.86	16.65	146	1375	248	87.6
Hilleshög HIL2479	101	326.5	98	8956	94	63.37	97	1737	93	27.37	17.36	1.03	16.33	239	1478	317	91.9
Hilleshög HIL2480	113	314.1	95	8946	94	58.80	90	1676	90	28.35	16.86	1.16	15.70	251	1626	372	90.9
Maribo MA717	121	335.5	101	10309	109	66.69	102	2047	110	30.77	17.69	0.92	16.77	166	1417	274	81.9
SX 1815	108	331.7	100	9330	98	65.30	100	1838	99	28.11	17.49	0.90	16.59	160	1467	254	85.6
SX 1835	114	320.2	97	9564	101	61.05	94	1824	98	29.75	16.98	0.98	16.00	186	1448	304	87.5
SV 231	123	324.2	98	9420	99	62.50	96	1818	98	29.13	17.16	0.96	16.20	196	1453	287	91.8
BTS 8815 (CommBench)	124	327.8	99	8965	94	63.85	98	1740	93	27.44	17.31	0.91	16.40	172	1506	242	88.8
Crystal 803 (CommBench)	125	327.9	99	9727	103	63.90	98	1892	102	29.62	17.31	0.92	16.39	172	1462	260	91.5
AP CK MOD RES RR#7	126	312.3	94	9524	100	58.12	89	1776	95	30.57	16.54	0.93	15.61	214	1357	285	92.5
AP CK MOD SUS RR#8	127	344.5	104	9848	104	70.03	107	2001	107	28.45	18.13	0.91	17.22	161	1431	264	89.3
Experimental Trial (Comm status)																	
BTS 8440	222	343.5	104	10275	108	69.79	107	2080	112	29.92	17.96	0.80	17.16	144	1315	271	86.8
BTS 8457	202	341.6	103	10294	108	69.11	106	2079	112	30.12	17.86	0.79	17.07	191	1251	256	87.1
BTS 8509	211	337.2	102	10022	106	67.42	103	1998	107	29.72	17.68	0.82	16.85	194	1319	265	87.1
BTS 8513	210	320.4	97	9436	99	60.95	93	1791	96	29.46	17.17	1.12	16.05	222	1652	407	92.5
BTS 8520	223	341.9	103	10149	107	69.19	106	2048	110	29.74	18.00	0.89	17.11	182	1452	286	87.4
BTS 8531	228	312.0	94	9938	105	57.77	89	1828	98	32.07	16.56	0.96	15.60	205	1487	327	91.5
BTS 8555	206	332.8	100	10035	106	65.73	101	1980	106	30.12	17.52	0.88	16.64	174	1366	304	89.5
BTS 8580	208	323.7	98	9182	97	62.25	95	1766	95	28.38	17.31	1.09	16.21	348	1432	399	90.7
BTS 8598	214	348.2	105	10453	110	71.63	110	2148	115	30.03	18.26	0.87	17.39	185	1350	299	85.5
Crystal 364	226	319.7	96	9854	104	60.72	93	1869	100	30.86	16.99	0.98	16.00	230	1581	306	90.7
Crystal 470	213	341.5	103	10455	110	69.07	106	2113	113	30.63	17.93	0.87	17.06	191	1380	289	89.1
Crystal 471	217	343.8	104	10212	108	69.91	107	2070	111	29.75	18.10	0.91	17.19	187	1327	324	84.4
Crystal 580	224	339.8	102	9961	105	68.42	105	1996	107	29.40	17.90	0.90	17.01	162	1394	314	88.2
Crystal 581	227	340.4	103	10177	107	68.60	105	2046	110	29.86	17.89	0.87	17.02	178	1296	306	82.1
Crystal 583	201	323.7	98	10060	106	62.26	95	1925	103	31.05	17.06	0.87	16.19	234	1323	284	95.8
Crystal 584	204	346.7	105	10169	107	71.02	109	2078	112	29.35	18.25	0.92	17.34	192	1389	313	91.5
Crystal 591	209	339.2	102	9898	104	68.18	104	1983	106	29.14	17.83	0.88	16.95	179	1369	303	92.2
Crystal 594	203	342.2	103	10083	106	69.31	106	2037	109	29.47	18.00	0.87	17.13	178	1300	305	83.6
Hilleshög HIL2493	220	327.8	99	9525	100	63.82	98	1851	99	28.99	17.40	0.99	16.41	251	1526	319	90.6
Hilleshög HIL2494	229	318.4	96	9710	102	60.21	92	1830	98	30.53	16.98	1.04	15.94	264	1557	352	87.5
Hilleshög HIL2532	216	329.3	99	9091	96	64.36	99	1770	95	27.61	17.44	0.97	16.47	199	1467	342	85.1
Hilleshög HIL2533	218	328.2	99	9735	103	63.99	98	1889	101	29.68	17.36	0.93	16.42	196	1418	322	89.8
Hilleshög HIL2534	221	337.4	102	9191	97	67.48	103	1832	98	27.28	17.78	0.92	16.86	164	1450	314	83.1
Hilleshög HIL2535	205	333.1	100	9896	104	65.84	101	1950	105	29.72	17.58	0.91	16.68	182	1392	314	90.2
SV 251	207	330.2	100	9544	101	64.73	99	1866	100	28.97	17.44	0.93	16.51	197	1514	292	87.1
SV 254	212	325.0	98	9716	102	62.77	96	1872	100	29.86	17.28	1.00	16.28	240	1492	341	86.3
SV 255	215	328.8	99	9996	105	64.20	98	1946	104	30.35	17.38	0.93	16.45	199	1475	308	88.7
SV 256	225	331.9	100	9520	100	65.35	100	1873	101	28.69	17.58	0.98	16.60	213	1490	342	85.3
SV 345	219	327.9	99	9728	103	63.84	98	1890	101	29.75	17.32	0.92	16.40	220	1469	292	87.5
SV 347	230	329.4	99	9863	104	64.41	99	1925	103	29.86	17.41	0.93	16.48	190	1483	306	83.6
BTS 8815 (CommBench)	231	333.6	101	9532	100	66.05	101	1882	101	28.60	17.53	0.85	16.68	191	1476	240	89.1
Crystal 803 (CommBench)	232	337.6	102	9741	103	67.52	103	1945	104	28.90	17.76	0.89	16.87	177	1405	297	91.0
BTS 8927 (CommBench)	233	333.7	101	9525	100	66.07	101	1877	101	28.76	17.54	0.85	16.69	216	1346	277	91.9
HIL2389 (CommBench)	234	321.5	97	9154	96	61.39	94	1746	94	28.40	17.06	0.97	16.09	224	1546	312	86.6
BTS 8156 (1stYearBench)	235	323.5	98	9558	101	62.16	95	1831	98	29.63	17.11	0.93	16.18	210	1560	279	90.9
AP CK MOD RES RR#7	236	323.1	97	10028	106	62.01	95	1917	103	31.15	17.05	0.88	16.17	223	1271	307	90.7
Comm Benchmark Mean		331.6		9488		65.26		1863		28.67	17.47	0.89		162	1422	252	88.7
Comm Trial Mean		329.0		9560		64.30		1867		29.07	17.39	0.94		181	1445	281	88.9
Coeff. of Var. (%)		2.7		4.6		5.2		6.2		3.9	2.4	5.4		13.4	3.9	9.6	7.5
Mean LSD (0.05)		8.2		387		3.04		102		1.03	0.38	0.05		23	54	26	5.4
Mean LSD (0.01)		10.8		509		4.01		135		1.36	0.50	0.06		31	71	34	7.1
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Caledonia ND

Created 10/06/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs.

Trial # = 258305

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 15. 2025 Performance of Varieties - ACSC RR Official Trials
Scandia MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	279.4	95	12127	98	45.93	89	1995	92	43.20	15.34	1.37	13.97	435	1393	529	55.0
BTS 8034	122	292.0	99	12968	105	50.60	98	2248	104	44.52	15.99	1.39	14.60	388	1627	505	58.0
BTS 8156	118	298.2	101	12903	105	52.89	103	2286	106	43.35	16.28	1.37	14.91	359	1632	498	61.5
BTS 8226	117	297.4	101	13007	105	52.59	102	2300	106	43.62	16.13	1.26	14.87	389	1371	469	61.2
BTS 8270	116	312.4	106	12893	104	58.15	113	2391	111	41.42	16.83	1.21	15.62	309	1416	452	53.5
BTS 8365	120	307.3	104	12593	102	56.26	109	2306	107	41.09	16.55	1.19	15.36	267	1373	455	50.6
BTS 8927 (CommBench)	115	299.1	102	12660	103	53.22	103	2254	104	42.24	16.16	1.21	14.95	310	1378	455	58.1
Crystal 022	105	300.6	102	12687	103	53.80	105	2262	105	42.22	16.31	1.28	15.03	326	1444	486	67.6
Crystal 130	110	307.6	104	13328	108	56.37	110	2446	113	43.43	16.60	1.23	15.37	334	1446	445	65.0
Crystal 138	119	310.2	105	13109	106	57.32	111	2425	112	42.36	16.64	1.13	15.51	260	1442	399	57.1
Crystal 260	104	323.6	110	13845	112	62.30	121	2665	123	42.83	17.24	1.07	16.17	261	1385	362	63.6
Crystal 269	107	291.9	99	12837	104	50.57	98	2219	103	43.87	15.97	1.37	14.60	410	1550	499	53.9
Crystal 361	111	316.0	107	13322	108	59.49	116	2523	117	42.10	16.86	1.07	15.79	289	1252	389	61.8
Crystal 369	109	291.5	99	12536	102	50.40	98	2167	100	43.08	15.87	1.30	14.57	356	1459	490	53.7
Crystal 793	112	297.3	101	12952	105	52.58	102	2287	106	43.68	16.08	1.21	14.87	346	1350	453	61.8
Crystal 912	102	289.4	98	13803	112	49.65	96	2374	110	47.60	15.83	1.36	14.47	461	1329	534	59.6
Hilleshög HIL2389 (CommBench)	103	283.3	96	11873	96	47.37	92	1996	92	41.58	15.46	1.30	14.16	367	1557	455	48.6
Hilleshög HIL2479	101	274.9	93	12090	98	44.29	86	1958	91	43.63	15.09	1.34	13.75	489	1482	466	61.6
Hilleshög HIL2480	113	290.2	99	13375	108	49.95	97	2299	106	46.16	15.80	1.28	14.52	429	1368	475	53.0
Maribo MA717	121	267.8	91	12570	102	41.65	81	1952	90	47.04	14.60	1.21	13.39	425	1493	386	53.8
SX 1815	108	274.9	93	12019	97	44.27	86	1938	90	43.48	15.04	1.29	13.75	351	1522	462	49.5
SX 1835	114	290.3	99	13548	110	49.97	97	2339	108	46.59	15.85	1.33	14.52	367	1520	495	59.8
SV 231	123	292.2	99	13395	109	50.69	98	2321	107	45.87	15.81	1.20	14.61	339	1441	420	70.8
BTS 8815 (CommBench)	124	290.2	99	12092	98	49.92	97	2077	96	41.76	15.82	1.31	14.51	355	1522	480	57.7
Crystal 803 (CommBench)	125	304.9	104	12751	103	55.38	108	2321	107	41.73	16.31	1.06	15.25	260	1289	385	67.2
AP CK MOD RES RR#7	126	278.5	95	13347	108	45.62	89	2180	101	48.00	15.30	1.37	13.93	472	1307	542	62.4
AP CK MOD SUS RR#8	127	310.5	105	13281	108	57.47	112	2462	114	42.88	16.71	1.18	15.53	280	1415	438	54.7
Experimental Trial (Comm status)																	
BTS 8440	222	315.0	107	13178	107	58.93	114	2467	114	42.50	16.72	1.02	15.70	238	1291	394	64.7
BTS 8457	202	304.7	104	12962	105	55.21	107	2377	110	42.21	16.24	0.98	15.25	303	1145	385	56.8
BTS 8509	211	306.7	104	12512	101	55.97	109	2278	105	41.06	16.36	1.02	15.33	280	1320	368	61.5
BTS 8513	210	302.8	103	11902	96	54.55	106	2140	99	39.33	16.46	1.32	15.15	332	1610	528	51.0
BTS 8520	223	298.6	101	13206	107	53.00	103	2350	109	44.23	16.08	1.17	14.92	313	1304	487	52.9
BTS 8531	228	292.6	99	13132	106	50.83	99	2292	106	45.05	15.72	1.12	14.60	353	1405	407	59.7
BTS 8555	206	306.1	104	12274	99	55.69	108	2246	104	40.33	16.33	1.06	15.27	257	1289	426	52.8
BTS 8580	208	299.9	102	11725	95	53.46	104	2110	98	38.38	16.09	1.10	14.99	255	1358	442	57.1
BTS 8598	214	305.0	104	12319	100	55.31	107	2240	104	40.68	16.36	1.13	15.23	278	1412	438	65.0
Crystal 364	226	276.1	94	13116	106	44.85	87	2128	98	47.61	15.06	1.25	13.80	421	1586	447	66.3
Crystal 470	213	298.6	101	12718	103	53.02	103	2276	105	42.42	16.07	1.14	14.94	319	1306	458	62.3
Crystal 471	217	298.8	102	12847	104	53.08	103	2278	105	43.10	16.06	1.13	14.94	321	1233	455	55.9
Crystal 580	224	285.7	97	12059	98	48.33	94	2055	95	41.80	15.50	1.20	14.30	398	1411	457	53.2
Crystal 581	227	296.1	101	12668	103	52.08	101	2244	104	42.46	16.00	1.18	14.82	313	1386	475	54.5
Crystal 583	201	291.8	99	12365	100	50.51	98	2132	99	42.38	15.69	1.11	14.58	363	1286	429	59.6
Crystal 584	204	298.6	101	11931	97	52.99	103	2147	99	40.07	16.01	1.10	14.92	288	1373	421	58.3
Crystal 591	209	311.6	106	12582	102	57.71	112	2348	109	40.29	16.71	1.12	15.59	244	1323	458	56.2
Crystal 594	203	296.5	101	12897	104	52.22	101	2268	105	43.41	15.91	1.09	14.82	301	1400	402	61.7
Hilleshög HIL2493	220	274.7	93	12466	101	44.37	86	1993	92	45.98	15.01	1.29	13.72	432	1584	469	61.2
Hilleshög HIL2494	229	278.3	95	12424	101	45.65	89	2035	94	44.61	15.32	1.38	13.93	352	1691	546	55.7
Hilleshög HIL2532	216	272.7	93	10894	88	43.65	85	1731	80	40.50	14.92	1.31	13.61	428	1498	503	40.1
Hilleshög HIL2533	218	282.6	96	12133	98	47.24	92	2008	93	43.07	15.30	1.17	14.13	338	1492	426	58.9
Hilleshög HIL2534	221	278.2	95	12304	100	45.64	89	2020	93	43.94	15.27	1.38	13.90	386	1605	545	57.9
Hilleshög HIL2535	205	302.2	103	12886	104	54.34	106	2303	107	42.96	16.19	1.11	15.08	245	1460	424	51.4
SV 251	207	290.1	99	12707	103	49.92	97	2200	102	43.75	15.61	1.12	14.50	353	1522	376	51.8
SV 254	212	290.3	99	13377	108	49.98	97	2295	106	46.19	15.75	1.24	14.51	319	1546	480	53.5
SV 255	215	284.9	97	13493	109	48.03	93	2281	106	46.73	15.47	1.20	14.26	354	1466	450	59.0
SV 256	225	275.0	93	12422	101	44.44	86	2010	93	45.33	15.06	1.34	13.73	397	1541	532	54.5
SV 345	219	284.2	97	12548	102	47.79	93	2112	98	44.59	15.49	1.29	14.20	353	1602	489	60.1
SV 347	230	280.7	95	12342	100	46.53	90	2046	95	43.81	15.37	1.34	14.03	411	1597	504	60.5
BTS 8815 (CommBench)	231	291.4	99	12451	101	50.37	98	2159	100	42.79	15.88	1.32	14.56	414	1635	483	52.4
Crystal 803 (CommBench)	232	297.8	101	12297	100	52.72	102	2183	101	41.03	16.03	1.13	14.91	296	1387	432	59.3
BTS 8927 (CommBench)	233	311.9	106	12901	105	57.83	112	2400	111	41.27	16.62	1.03	15.59	249	1271	403	63.2
HIL2389 (CommBench)	234	276.4	94	11727	95	44.97	87	1906	88	42.22	15.22	1.40	13.82	503	1657	521	43.3
BTS 8156 (1stYearBench)	235	293.7	100	11894	96	51.25	100	2077	96	40.61	15.89	1.21	14.67	371	1612	425	58.2
AP CK MOD RES RR#7	236	285.5	97	13024	106	48.26	94	2195	102	45.92	15.58	1.34	14.25	467	1457	530	63.6
Comm Benchmark Mean		294.4		12344		51.47		2162		41.83	15.94	1.22		323	1437	444	57.9
Comm Trial Mean		295.2		12886		51.80		2259		43.68	16.02	1.26		357	1436	460	58.6
Coeff. of Var. (%)		3.5		6.7		7.5		9.1		6.1	2.8	8.8		14.8	4.3	14.3	16.8
Mean LSD (0.05)		10.0		813		3.70		195		2.48	0.43	0.11		51	58	63	8.5
Mean LSD (0.01)		13.2		1071		4.87		257		3.26	0.57	0.14		67	76	83	11.2
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Scandia MN — Created 10/03/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258306

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 16. 2025 Performance of Varieties - ACSC RR Official Trials
Reynolds ND

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	335.0	101	12309	107	66.53	101	2439	107	36.85	17.62	0.87	16.75	276	1245	244	78.4
BTS 8034	122	312.9	94	11253	98	58.34	89	2094	92	36.19	16.82	1.17	15.65	410	1560	341	72.6
BTS 8156	118	331.0	99	11712	102	65.03	99	2300	101	35.29	17.52	0.97	16.55	297	1425	267	70.6
BTS 8226	117	336.5	101	11678	101	67.07	102	2333	103	34.72	17.74	0.92	16.82	315	1227	268	78.9
BTS 8270	116	335.4	101	11531	100	66.67	101	2285	100	34.48	17.70	0.93	16.77	277	1361	258	67.4
BTS 8365	120	340.0	102	11348	98	68.36	104	2278	100	33.43	17.94	0.94	17.00	295	1249	290	69.9
BTS 8927 (CommBench)	115	334.7	101	11630	101	66.39	101	2308	101	34.76	17.67	0.94	16.73	312	1240	284	76.0
Crystal 022	105	329.9	99	11383	99	64.63	98	2219	98	34.61	17.50	1.00	16.50	353	1302	304	73.5
Crystal 130	110	332.0	100	11869	103	65.42	100	2339	103	35.67	17.54	0.94	16.60	310	1332	264	75.9
Crystal 138	119	324.9	98	11106	96	62.77	96	2139	94	34.35	17.20	0.96	16.24	299	1317	281	75.0
Crystal 260	104	332.6	100	11928	103	65.62	100	2360	104	35.60	17.53	0.90	16.63	287	1331	242	67.3
Crystal 269	107	340.0	102	11763	102	68.35	104	2362	104	34.70	17.94	0.94	17.00	300	1339	261	71.6
Crystal 361	111	340.4	102	11982	104	68.50	104	2412	106	35.16	17.88	0.86	17.02	269	1211	246	77.8
Crystal 369	109	333.2	100	12314	107	65.84	100	2433	107	36.93	17.64	0.98	16.66	288	1413	280	75.1
Crystal 793	112	338.1	102	11700	101	67.65	103	2342	103	34.67	17.86	0.96	16.90	285	1310	288	75.4
Crystal 912	102	311.9	94	11952	104	57.97	88	2211	97	38.59	16.57	0.97	15.60	427	1220	273	73.6
Hilleshög HIL2389 (CommBench)	103	331.4	100	11617	101	65.17	99	2284	100	35.01	17.49	0.92	16.57	287	1304	266	74.4
Hilleshög HIL2479	101	332.6	100	10842	94	65.62	100	2142	94	32.48	17.60	0.97	16.63	359	1235	291	81.7
Hilleshög HIL2480	113	309.6	93	10906	95	57.12	87	2010	88	35.36	16.71	1.22	15.49	523	1252	422	75.6
Maribo MA717	121	311.8	94	11204	97	57.94	88	2082	91	35.89	16.60	1.01	15.59	400	1302	291	71.3
SX 1815	108	323.6	97	11069	96	62.31	95	2131	94	34.23	17.14	0.95	16.19	305	1282	287	74.2
SX 1835	114	310.0	93	11775	102	57.26	87	2177	96	37.93	16.50	1.00	15.50	372	1349	278	78.9
SV 231	123	323.0	97	11960	104	62.09	94	2302	101	36.89	17.08	0.92	16.16	308	1335	250	76.3
BTS 8815 (CommBench)	124	326.3	98	10940	95	63.30	96	2114	93	33.49	17.32	1.01	16.31	330	1444	278	70.3
Crystal 803 (CommBench)	125	339.0	102	11931	103	67.99	103	2396	105	35.24	17.81	0.86	16.95	256	1247	243	76.5
AP CK MOD RES RR#7	126	309.5	93	11909	103	57.07	87	2196	97	38.50	16.50	1.02	15.48	397	1290	304	82.3
AP CK MOD SUS RR#8	127	340.6	102	12053	105	68.59	104	2433	107	35.45	17.90	0.87	17.03	226	1264	253	74.5
Experimental Trial (Comm status)																	
BTS 8440	222	347.7	104	11850	103	71.25	108	2406	106	34.23	18.25	0.87	17.39	256	1250	254	80.8
BTS 8457	202	327.1	98	11383	99	63.56	97	2210	97	34.86	17.23	0.89	16.35	357	1047	289	71.9
BTS 8509	211	345.7	104	12222	106	70.53	107	2490	109	35.10	18.09	0.80	17.29	240	1146	237	69.6
BTS 8513	210	325.5	98	11287	98	62.93	96	2196	97	34.48	17.41	1.14	16.27	394	1552	341	72.7
BTS 8520	223	337.2	101	12438	108	67.34	102	2470	109	36.75	17.74	0.89	16.85	284	1282	246	75.5
BTS 8531	228	317.4	95	11764	102	59.94	91	2213	97	36.98	16.89	1.01	15.87	381	1307	308	72.6
BTS 8555	206	329.6	99	11765	102	64.51	98	2303	101	35.53	17.34	0.87	16.48	297	1169	262	76.5
BTS 8580	208	342.2	103	11319	98	69.20	105	2286	100	32.94	18.00	0.90	17.10	277	1238	275	79.5
BTS 8598	214	343.3	103	11692	101	69.61	106	2374	104	33.88	18.00	0.85	17.15	269	1202	245	78.0
Crystal 364	226	320.0	96	11460	99	60.91	93	2182	96	35.66	17.08	1.07	16.01	397	1439	316	79.6
Crystal 470	213	338.3	102	12540	109	67.76	103	2521	111	36.73	17.83	0.92	16.91	294	1300	265	75.6
Crystal 471	217	332.7	100	11462	99	65.66	100	2258	99	34.33	17.53	0.90	16.64	336	1117	281	75.9
Crystal 580	224	343.1	103	12517	109	69.51	106	2540	112	36.26	17.99	0.85	17.14	244	1302	230	78.5
Crystal 581	227	349.1	105	12224	106	71.79	109	2527	111	34.85	18.31	0.87	17.45	243	1215	267	67.3
Crystal 583	201	326.0	98	11653	101	63.14	96	2258	99	35.72	17.22	0.92	16.31	416	1117	277	79.8
Crystal 584	204	351.9	106	12186	106	72.80	111	2531	111	34.50	18.49	0.91	17.59	253	1260	288	77.1
Crystal 591	209	349.5	105	12296	107	71.94	109	2523	111	35.35	18.37	0.91	17.47	268	1242	285	73.4
Crystal 594	203	347.4	104	12550	109	71.13	108	2580	113	36.02	18.18	0.82	17.36	243	1154	248	72.9
Hilleshög HIL2493	220	314.1	94	11569	100	58.74	89	2176	96	36.42	16.70	0.98	15.71	350	1279	305	78.6
Hilleshög HIL2494	229	320.3	96	11825	103	61.02	93	2254	99	36.92	17.02	1.00	16.02	319	1364	318	77.0
Hilleshög HIL2532	216	332.1	100	11101	96	65.43	100	2187	96	33.33	17.52	0.93	16.60	245	1314	286	75.8
Hilleshög HIL2533	218	329.5	99	12574	109	64.46	98	2466	108	37.94	17.33	0.86	16.48	275	1281	235	74.4
Hilleshög HIL2534	221	309.2	93	10336	90	56.87	87	1901	84	33.18	16.59	1.11	15.47	445	1392	344	71.1
Hilleshög HIL2535	205	329.8	99	11623	101	64.57	98	2291	101	35.16	17.38	0.90	16.49	220	1342	272	80.0
SV 251	207	342.2	103	13127	114	69.20	105	2645	116	38.36	17.94	0.83	17.11	232	1337	215	71.5
SV 254	212	324.9	98	12398	108	62.71	95	2395	105	38.12	17.17	0.94	16.23	278	1316	286	78.4
SV 255	215	316.1	95	12133	105	59.45	90	2281	100	38.48	16.83	1.03	15.79	428	1332	300	72.5
SV 256	225	319.3	96	11574	100	60.63	92	2203	97	36.39	16.93	0.97	15.95	354	1337	285	66.9
SV 345	219	324.2	97	12686	110	62.47	95	2441	107	39.16	17.21	1.00	16.21	313	1415	299	78.9
SV 347	230	331.8	100	11091	96	65.34	99	2178	96	33.61	17.58	0.97	16.60	290	1342	313	70.4
BTS 8815 (CommBench)	231	329.7	99	11322	98	64.54	98	2217	97	34.42	17.51	1.03	16.48	351	1434	305	71.9
Crystal 803 (CommBench)	232	328.1	99	11422	99	63.92	97	2232	98	34.48	17.37	0.96	16.41	319	1356	281	81.9
BTS 8927 (CommBench)	233	341.6	103	11905	103	69.00	105	2399	105	35.04	17.92	0.85	17.07	269	1195	250	77.1
HIL2389 (CommBench)	234	331.9	100	11469	99	65.38	99	2255	99	34.55	17.48	0.89	16.60	306	1263	254	72.9
BTS 8156 (1stYearBench)	235	332.7	100	11401	99	65.67	100	2243	99	34.00	17.70	1.06	16.63	359	1464	313	76.9
AP CK MOD RES RR#7	236	307.0	92	12036	104	56.03	85	2182	96	39.46	16.41	1.06	15.35	438	1231	351	82.6
Comm Benchmark Mean		332.9		11530		65.71		2276		34.63	17.57	0.93		296	1309	267	74.3
Comm Trial Mean		328.4		11617		64.06		2264		35.42	17.38	0.96		325	1311	280	74.6
Coeff. of Var. (%)		2.9		4.9		5.4		6.7		4.3	2.3	8.9		19.3	4.0	15.7	11.5
Mean LSD (0.05)		8.8		521		3.26		140		1.33	0.38	0.08		60	49	41	7.7
Mean LSD (0.01)		11.6		686		4.29		185		1.75	0.50	0.11		79	65	54	10.1
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Reynolds ND

Created 09/22/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs.

Trial # = 258307

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 17. 2025 Performance of Varieties - ACSC RR Official Trials
Alvarado MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	299.6	99	11900	104	53.43	97	2117	102	39.90	15.95	0.97	14.98	190	1317	334	62.5
BTS 8034	122	289.0	95	10984	96	49.49	90	1878	91	38.19	15.48	1.03	14.45	185	1480	347	55.4
BTS 8156	118	298.2	98	11414	100	52.89	96	2022	98	38.37	15.97	1.06	14.91	186	1490	361	56.2
BTS 8226	117	312.3	103	11403	100	58.13	106	2117	102	36.54	16.52	0.90	15.62	174	1247	298	60.4
BTS 8270	116	307.7	101	10964	96	56.42	103	2009	97	35.70	16.41	1.03	15.38	170	1405	361	50.6
BTS 8365	120	309.3	102	10256	90	57.02	104	1886	91	33.24	16.44	0.97	15.47	158	1330	342	42.1
BTS 8927 (CommBench)	115	313.6	103	11631	102	58.60	106	2164	105	36.96	16.66	0.97	15.69	163	1275	356	59.4
Crystal 022	105	310.4	102	11278	99	57.40	104	2086	101	36.20	16.53	1.01	15.52	164	1310	372	62.1
Crystal 130	110	306.7	101	11295	99	56.05	102	2064	100	36.88	16.31	0.98	15.33	194	1331	335	62.9
Crystal 138	119	302.9	100	11512	101	54.64	99	2072	100	37.93	16.18	1.03	15.15	163	1381	367	53.4
Crystal 260	104	299.9	99	11562	101	53.54	97	2073	100	38.55	15.89	0.90	14.99	134	1264	317	61.2
Crystal 269	107	305.0	100	11064	97	55.41	101	2002	97	36.51	16.30	1.06	15.24	195	1434	366	47.8
Crystal 361	111	309.8	102	11606	102	57.20	104	2139	103	37.32	16.40	0.90	15.50	164	1218	314	64.6
Crystal 369	109	294.5	97	10644	93	51.53	94	1863	90	36.14	15.81	1.08	14.73	212	1441	376	48.8
Crystal 793	112	294.1	97	11274	99	51.37	93	1967	95	38.47	15.81	1.11	14.70	257	1485	370	62.8
Crystal 912	102	290.2	95	11892	104	49.94	91	2038	99	41.03	15.58	1.06	14.52	236	1321	386	63.6
Hilleshög HIL2389 (CommBench)	103	306.8	101	11558	101	56.09	102	2116	102	37.68	16.31	0.97	15.34	147	1433	317	55.0
Hilleshög HIL2479	101	309.4	102	11568	101	57.05	104	2137	103	37.44	16.52	1.05	15.47	232	1428	350	60.1
Hilleshög HIL2480	113	294.7	97	10913	95	51.59	94	1903	92	36.88	15.88	1.14	14.74	239	1430	416	59.4
Maribo MA717	121	302.5	100	11384	100	54.50	99	2046	99	37.76	16.19	1.06	15.13	211	1467	355	51.7
SX 1815	108	294.7	97	11003	96	51.61	94	1921	93	37.48	15.88	1.15	14.73	229	1580	385	56.1
SX 1835	114	290.8	96	11687	102	50.18	91	2017	98	40.19	15.72	1.18	14.54	194	1537	436	62.0
SV 231	123	293.6	97	11621	102	51.19	93	2035	98	39.44	15.72	1.04	14.68	192	1512	337	64.7
BTS 8815 (CommBench)	124	302.4	99	11068	97	54.45	99	1990	96	36.75	16.14	1.03	15.11	201	1585	302	58.9
Crystal 803 (CommBench)	125	292.9	96	11454	100	50.96	93	2002	97	38.89	15.63	0.98	14.65	185	1315	341	62.0
AP CK MOD RES RR#7	126	285.5	94	12283	107	48.20	88	2059	100	43.51	15.30	1.03	14.27	250	1314	361	63.7
AP CK MOD SUS RR#8	127	311.3	102	11754	103	57.73	105	2178	105	37.71	16.45	0.88	15.57	155	1238	298	66.2
Experimental Trial (Comm status)																	
BTS 8440	222	310.3	102	11529	101	57.39	104	2140	103	37.05	16.43	0.92	15.52	161	1260	319	59.9
BTS 8457	202	302.1	99	11253	98	54.35	99	2014	97	37.79	15.98	0.91	15.08	207	1178	317	63.9
BTS 8509	211	311.5	103	11871	104	57.87	105	2224	108	38.25	16.37	0.82	15.56	151	1197	268	61.7
BTS 8513	210	292.5	96	11397	100	50.77	92	1965	95	38.87	15.85	1.21	14.64	179	1482	481	54.2
BTS 8520	223	290.4	96	11316	99	49.99	91	1962	95	39.42	15.54	1.05	14.49	214	1325	394	54.3
BTS 8531	228	293.8	97	11280	99	51.28	93	1958	95	38.92	15.75	1.08	14.67	254	1434	369	64.9
BTS 8555	206	303.3	100	11709	102	54.81	100	2124	103	38.98	16.09	0.97	15.13	164	1250	356	66.6
BTS 8580	208	313.7	103	10389	91	58.68	107	1958	95	33.45	16.50	0.85	15.66	142	1223	281	61.3
BTS 8598	214	303.4	100	11355	99	54.83	100	2067	100	37.83	16.14	1.00	15.14	183	1234	380	60.8
Crystal 364	226	298.1	98	12247	107	52.85	96	2165	105	41.05	15.93	1.01	14.92	236	1441	324	66.4
Crystal 470	213	286.9	94	11325	99	48.73	89	1933	93	40.09	15.31	1.00	14.31	200	1276	371	68.9
Crystal 471	217	306.8	101	11283	99	56.09	102	2051	99	36.95	16.26	0.93	15.34	169	1209	340	55.7
Crystal 580	224	299.3	98	11795	103	53.29	97	2097	101	39.95	15.94	1.02	14.92	198	1348	366	54.6
Crystal 581	227	317.2	104	11745	103	59.98	109	2235	108	37.27	16.74	0.92	15.83	163	1271	312	59.1
Crystal 583	201	303.3	100	12082	106	54.82	100	2205	107	39.98	16.08	0.94	15.15	210	1281	308	65.4
Crystal 584	204	309.2	102	11211	98	57.00	104	2067	100	36.54	16.45	1.01	15.44	162	1308	380	67.0
Crystal 591	209	317.1	104	11908	104	59.94	109	2266	110	37.45	16.75	0.90	15.86	150	1237	312	65.3
Crystal 594	203	312.7	103	11960	105	58.29	106	2234	108	38.86	16.49	0.92	15.58	195	1228	320	58.9
Hilleshög HIL2493	220	292.8	96	11840	104	50.87	92	2044	99	40.48	15.65	1.01	14.64	187	1396	345	57.6
Hilleshög HIL2494	229	292.5	96	11625	102	50.77	92	2025	98	39.88	15.70	1.09	14.61	179	1507	377	68.0
Hilleshög HIL2532	216	294.7	97	10875	95	51.61	94	1913	92	36.67	15.74	0.99	14.76	158	1391	343	52.7
Hilleshög HIL2533	218	291.0	96	11748	103	50.22	91	2022	98	40.55	15.58	1.04	14.54	172	1466	362	64.9
Hilleshög HIL2534	221	296.4	98	11224	98	52.21	95	1997	97	38.55	15.83	1.07	14.76	176	1479	377	53.7
Hilleshög HIL2535	205	302.2	99	11055	97	54.38	99	1977	96	36.80	16.08	0.99	15.10	152	1460	328	55.2
SV 251	207	296.2	97	10877	95	52.16	95	1918	93	37.43	15.74	0.99	14.76	187	1505	296	55.7
SV 254	212	300.2	99	11493	101	53.65	98	2052	99	38.41	15.98	0.97	15.02	188	1452	304	52.3
SV 255	215	295.7	97	11400	100	51.96	94	2000	97	38.48	15.77	0.99	14.78	170	1452	318	61.9
SV 256	225	295.2	97	11274	99	51.77	94	1965	95	38.70	15.78	1.06	14.72	179	1566	343	55.6
SV 345	219	297.6	98	11664	102	52.69	96	2076	100	39.56	15.84	0.99	14.85	174	1445	332	50.1
SV 347	230	301.8	99	11767	103	54.25	99	2120	103	39.28	16.15	1.09	15.06	175	1551	375	63.0
BTS 8815 (CommBench)	231	299.2	98	11425	100	53.28	97	2039	99	38.12	16.00	1.04	14.96	182	1489	347	49.7
Crystal 803 (CommBench)	232	305.9	101	11909	104	55.75	101	2175	105	39.05	16.20	0.92	15.29	166	1321	306	66.1
BTS 8927 (CommBench)	233	314.6	104	11288	99	59.01	107	2098	101	36.08	16.62	0.91	15.72	139	1204	336	67.3
HIL2389 (CommBench)	234	296.0	97	11089	97	52.06	95	1960	95	37.03	15.91	1.08	14.83	173	1463	388	51.8
BTS 8156 (1stYearBench)	235	299.9	99	11181	98	53.54	97	1996	97	37.38	15.95	0.96	15.00	200	1482	286	55.1
AP CK MOD RES RR#7	236	287.9	95	11887	104	49.10	89	2027	98	41.74	15.44	1.08	14.36	255	1362	388	59.3
Comm Benchmark Mean		303.9		11428		55.03		2068		37.57	16.19	0.99		174	1402	329	58.8
Comm Trial Mean		301.0		11369		53.95		2033		37.84	16.07	1.02		192	1391	352	58.3
Coeff. of Var. (%)		3.0		5.3		6.1		7.0		5.1	2.6	8.6		17.5	7.3	12.1	15.9
Mean LSD (0.05)		8.6		557		3.17		136		1.75	0.40	0.08		32	94	41	8.4
Mean LSD (0.01)		11.3		733		4.18		179		2.31	0.52	0.11		42	124	54	11.1
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Alvarado MN — Created 10/01/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258309

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 18. 2025 Performance of Varieties - ACSC RR Official Trials
Stephen MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	371.1	98	11251	99	79.87	97	2420	98	30.37	19.49	0.94	18.55	140	1630	245	75.7
BTS 8034	122	366.3	97	11364	100	78.10	95	2417	98	31.14	19.28	0.97	18.31	138	1750	239	71.3
BTS 8156	118	359.1	95	10984	97	75.44	92	2312	94	30.49	18.93	0.97	17.96	133	1719	247	80.4
BTS 8226	117	379.6	101	11341	100	83.01	101	2481	101	29.85	19.81	0.82	18.99	108	1521	196	82.2
BTS 8270	116	380.1	101	11383	100	83.20	101	2494	101	29.89	19.89	0.88	19.01	115	1584	220	71.4
BTS 8365	120	382.6	102	10797	95	84.11	103	2373	96	28.16	20.02	0.88	19.14	114	1575	226	69.3
BTS 8927 (CommBench)	115	377.8	100	11276	99	82.36	100	2456	100	29.97	19.76	0.88	18.88	137	1541	221	78.6
Crystal 022	105	385.6	102	11405	101	85.22	104	2521	102	29.53	20.12	0.84	19.28	113	1492	215	77.6
Crystal 130	110	375.6	100	11631	103	81.55	99	2527	102	30.95	19.67	0.89	18.78	122	1560	229	75.3
Crystal 138	119	379.0	101	11214	99	82.78	101	2453	99	29.56	19.84	0.90	18.94	134	1596	222	70.5
Crystal 260	104	374.6	99	11309	100	81.16	99	2446	99	30.31	19.55	0.82	18.73	120	1512	193	75.4
Crystal 269	107	379.4	101	11916	105	82.96	101	2606	106	31.33	19.92	0.94	18.98	124	1639	250	73.5
Crystal 361	111	377.5	100	11214	99	82.25	100	2443	99	29.72	19.72	0.85	18.87	122	1509	213	73.8
Crystal 369	109	380.2	101	12184	107	83.23	102	2663	108	32.14	19.97	0.97	19.00	130	1668	261	77.0
Crystal 793	112	378.7	100	11795	104	82.67	101	2576	104	31.14	19.79	0.85	18.94	120	1494	222	79.5
Crystal 912	102	373.6	99	12701	112	80.79	99	2745	111	33.99	19.51	0.83	18.68	132	1445	216	83.6
Hilleshög HIL2389 (CommBench)	103	373.7	99	11198	99	80.83	99	2420	98	30.00	19.63	0.95	18.68	124	1720	234	68.7
Hilleshög HIL2479	101	375.7	100	11555	102	81.56	99	2507	102	30.75	19.70	0.92	18.78	135	1557	250	72.9
Hilleshög HIL2480	113	369.2	98	11506	101	79.18	97	2467	100	31.09	19.56	1.10	18.46	156	1766	323	70.3
Maribo MA717	121	366.8	97	11754	104	78.27	95	2508	102	32.09	19.34	1.00	18.34	151	1771	252	59.8
SX 1815	108	373.1	99	11160	98	80.63	98	2414	98	29.93	19.58	0.93	18.65	125	1683	233	65.4
SX 1835	114	368.5	98	11743	104	78.92	96	2513	102	31.86	19.42	0.99	18.43	136	1765	248	70.6
SV 231	123	374.2	99	11941	105	81.02	99	2585	105	31.96	19.64	0.94	18.70	122	1703	229	77.3
BTS 8815 (CommBench)	124	379.0	101	11253	99	82.80	101	2461	100	29.67	19.87	0.92	18.95	131	1720	210	78.8
Crystal 803 (CommBench)	125	376.9	100	11637	103	82.01	100	2535	103	30.87	19.73	0.89	18.84	117	1605	223	77.2
AP CK MOD RES RR#7	126	367.6	98	12738	112	78.57	96	2721	110	34.63	19.28	0.90	18.38	153	1539	232	82.6
AP CK MOD SUS RR#8	127	378.3	100	11254	99	82.52	101	2456	100	29.74	19.79	0.88	18.91	120	1560	223	77.8
Experimental Trial (Comm status)																	
BTS 8440	222	379.2	101	11760	104	82.86	101	2571	104	31.02	19.81	0.85	18.96	110	1517	187	84.4
BTS 8457	202	388.2	103	11300	100	86.22	105	2504	101	29.13	20.22	0.81	19.40	115	1422	179	83.3
BTS 8509	211	386.6	103	11954	105	85.63	104	2656	108	30.81	20.14	0.79	19.34	107	1362	179	74.6
BTS 8513	210	385.8	102	11204	99	85.32	104	2483	101	29.11	20.38	1.10	19.28	134	1783	294	81.6
BTS 8520	223	373.1	99	12043	106	80.61	98	2611	106	32.19	19.55	0.90	18.65	154	1497	206	82.8
BTS 8531	228	382.4	101	12386	109	84.07	103	2723	110	32.31	20.02	0.90	19.13	118	1532	215	86.3
BTS 8555	206	381.8	101	10882	96	83.82	102	2389	97	28.42	19.91	0.81	19.10	103	1398	192	77.7
BTS 8580	208	383.9	102	10741	95	84.60	103	2367	96	27.98	20.16	0.97	19.18	123	1604	238	83.6
BTS 8598	214	386.8	103	11460	101	85.70	105	2550	103	29.63	20.25	0.92	19.33	109	1546	216	74.7
Crystal 364	226	373.7	99	12052	106	80.83	99	2616	106	32.01	19.65	0.96	18.69	125	1655	220	83.6
Crystal 470	213	373.0	99	11583	102	80.55	98	2502	101	31.16	19.50	0.85	18.65	123	1443	203	77.4
Crystal 471	217	388.0	103	11951	105	86.13	105	2656	108	30.76	20.30	0.90	19.40	109	1511	212	77.7
Crystal 580	224	377.1	100	11678	103	82.10	100	2543	103	31.13	19.75	0.91	18.85	117	1567	214	75.5
Crystal 581	227	383.4	102	11210	99	84.45	103	2474	100	29.18	20.06	0.89	19.18	155	1474	204	68.4
Crystal 583	201	381.5	101	11573	102	83.73	102	2539	103	30.42	19.90	0.83	19.07	124	1410	196	75.0
Crystal 584	204	388.4	103	11414	101	86.28	105	2545	103	29.35	20.27	0.84	19.42	107	1483	190	75.8
Crystal 591	209	386.2	102	11435	101	85.48	104	2536	103	29.55	20.19	0.87	19.32	111	1462	207	80.5
Crystal 594	203	382.1	101	12052	106	83.94	102	2646	107	31.62	19.94	0.85	19.09	116	1472	190	86.3
Hilleshög HIL2493	220	373.1	99	12175	107	80.59	98	2634	107	32.59	19.62	0.97	18.65	118	1687	224	74.2
Hilleshög HIL2494	229	374.9	99	11968	106	81.25	99	2599	105	32.01	19.78	1.06	18.73	124	1753	264	79.5
Hilleshög HIL2532	216	380.2	101	11349	100	83.25	102	2486	101	29.80	19.96	0.97	18.99	111	1629	234	65.3
Hilleshög HIL2533	218	375.2	100	11668	103	81.37	99	2528	102	31.20	19.68	0.94	18.74	115	1666	209	75.8
Hilleshög HIL2534	221	376.0	100	10726	95	81.69	100	2335	95	28.58	19.80	1.00	18.80	114	1709	250	64.8
Hilleshög HIL2535	205	377.7	100	11611	102	82.32	100	2534	103	30.78	19.79	0.92	18.87	117	1571	215	80.4
SV 251	207	375.6	100	11598	102	81.52	99	2525	102	30.85	19.80	1.04	18.76	122	1712	259	77.2
SV 254	212	374.4	99	11848	104	81.08	99	2563	104	31.86	19.67	0.98	18.69	129	1682	227	77.9
SV 255	215	370.1	98	11642	103	79.50	97	2500	101	31.58	19.46	0.97	18.49	122	1679	226	78.2
SV 256	225	383.4	102	11696	103	84.44	103	2575	104	30.58	20.06	0.91	19.16	108	1581	208	71.9
SV 345	219	372.3	99	11522	102	80.31	98	2491	101	30.75	19.60	0.97	18.63	128	1705	215	66.5
SV 347	230	377.8	100	11021	97	82.33	100	2408	98	29.20	19.84	0.97	18.87	126	1660	222	71.5
BTS 8815 (CommBench)	231	373.7	99	11175	99	80.83	99	2418	98	29.99	19.62	0.95	18.67	129	1638	215	78.1
Crystal 803 (CommBench)	232	377.2	100	11757	104	82.12	100	2558	104	31.24	19.79	0.94	18.85	125	1559	239	80.1
BTS 8927 (CommBench)	233	381.9	101	10982	97	83.87	102	2420	98	28.69	19.94	0.84	19.10	111	1459	187	78.1
HIL2389 (CommBench)	234	374.7	99	11450	101	81.18	99	2476	100	30.59	19.63	0.91	18.72	112	1599	203	69.2
BTS 8156 (1stYearBench)	235	364.2	97	10843	96	77.33	94	2314	94	29.62	19.20	0.98	18.22	131	1675	227	73.0
AP CK MOD RES RR#7	236	374.0	99	12888	114	80.92	99	2798	113	34.35	19.59	0.90	18.69	144	1504	205	80.7
Comm Benchmark Mean		376.9		11341		82.00		2468		30.13	19.75	0.91		127	1647	222	75.8
Comm Trial Mean		374.9		11537		81.30		2501		30.78	19.66	0.91		129	1616	232	74.7
Coeff. of Var. (%)		1.4		4.7		2.4		5.0		4.6	1.2	5.0		10.4	3.7	9.2	10.4
Mean LSD (0.05)		5.0		484		1.84		114		1.24	0.23	0.04		13	56	21	6.7
Mean LSD (0.01)		6.5		637		2.42		151		1.63	0.30	0.06		17	74	27	8.8
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Stephen MN — Created 09/29/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258310

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 19. 2025 Performance of Varieties - ACSC RR Official Trials
St. Thomas ND

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	LTM	Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	338.0	100	12719	109	67.64	100	2543	109	37.64	17.65	0.75	16.90	145	1305	183	92.0
BTS 8034	122	306.5	91	10483	90	55.98	83	1914	82	34.22	16.23	0.90	15.33	217	1481	224	86.8
BTS 8156	118	324.3	96	11163	96	62.55	92	2153	93	34.41	17.06	0.84	16.22	196	1367	219	87.5
BTS 8226	117	342.9	101	12327	106	69.42	103	2498	107	35.91	17.86	0.72	17.14	146	1218	179	92.4
BTS 8270	116	339.0	100	11645	100	68.00	100	2335	100	34.36	17.72	0.77	16.95	145	1313	193	81.7
BTS 8365	120	341.2	101	11497	99	68.80	102	2319	100	33.71	17.83	0.78	17.05	146	1318	198	80.5
BTS 8927 (CommBench)	115	338.5	100	12108	104	67.81	100	2421	104	35.85	17.69	0.76	16.93	170	1260	196	84.6
Crystal 022	105	344.7	102	11965	103	70.12	104	2439	105	34.60	17.99	0.76	17.23	127	1325	187	90.5
Crystal 130	110	329.9	98	11874	102	64.61	95	2327	100	35.98	17.26	0.77	16.49	139	1320	192	84.7
Crystal 138	119	342.9	101	11398	98	69.44	103	2312	99	33.18	17.88	0.74	17.14	133	1324	172	85.1
Crystal 260	104	331.1	98	11630	100	65.06	96	2284	98	35.16	17.32	0.77	16.55	152	1332	186	89.0
Crystal 269	107	337.1	100	11419	98	67.30	99	2281	98	33.83	17.71	0.85	16.86	166	1398	228	86.7
Crystal 361	111	345.7	102	12337	106	70.47	104	2514	108	35.73	18.02	0.73	17.29	140	1204	197	84.9
Crystal 369	109	337.4	100	12521	108	67.42	100	2500	107	37.11	17.73	0.85	16.88	155	1405	231	88.0
Crystal 793	112	336.2	99	12277	106	66.97	99	2443	105	36.55	17.61	0.80	16.81	161	1316	210	91.0
Crystal 912	102	307.6	91	12009	103	56.38	83	2202	95	39.03	16.22	0.84	15.38	247	1208	238	85.1
Hilleshög HIL2389 (CommBench)	103	338.6	100	11299	97	67.83	100	2261	97	33.43	17.70	0.77	16.93	135	1293	205	81.0
Hilleshög HIL2479	101	335.6	99	10481	90	66.74	99	2079	89	31.33	17.58	0.80	16.78	184	1229	227	89.4
Hilleshög HIL2480	113	339.3	100	10856	93	68.11	101	2181	94	31.93	17.82	0.85	16.97	184	1332	238	82.1
Maribo MA717	121	331.7	98	11272	97	65.30	97	2211	95	34.13	17.44	0.85	16.59	165	1400	225	81.5
SX 1815	108	334.2	99	11664	100	66.20	98	2313	99	34.88	17.42	0.71	16.71	124	1285	168	80.4
SX 1835	114	324.2	96	12185	105	62.54	92	2349	101	37.61	17.02	0.81	16.21	185	1364	197	88.6
SV 231	123	328.2	97	12351	106	64.00	95	2410	104	37.58	17.15	0.74	16.41	139	1303	180	88.6
BTS 8815 (CommBench)	124	339.0	100	11116	96	68.00	100	2234	96	32.70	17.74	0.79	16.95	150	1401	184	85.6
Crystal 803 (CommBench)	125	336.3	99	12004	103	67.01	99	2388	103	35.76	17.60	0.78	16.82	144	1309	209	88.1
AP CK MOD RES RR#7	126	322.5	95	11927	103	61.88	91	2288	98	37.01	16.92	0.79	16.13	175	1245	219	96.2
AP CK MOD SUS RR#8	127	338.0	100	11983	103	67.63	100	2397	103	35.49	17.63	0.73	16.90	148	1237	185	84.8
Experimental Trial (Comm status)																	
BTS 8440	222	339.8	100	11841	102	68.28	101	2378	102	34.86	17.73	0.75	16.98	150	1319	188	83.1
BTS 8457	202	342.8	101	12453	107	69.38	103	2515	108	36.44	17.81	0.67	17.14	147	1125	180	90.6
BTS 8509	211	335.5	99	12341	106	66.73	99	2446	105	36.94	17.50	0.70	16.80	173	1242	168	90.3
BTS 8513	210	339.0	100	11213	96	67.99	100	2249	97	33.05	17.81	0.87	16.94	151	1481	241	80.1
BTS 8520	223	332.7	98	12591	108	65.69	97	2471	106	38.14	17.39	0.74	16.65	146	1318	184	84.5
BTS 8531	228	329.2	97	12180	105	64.38	95	2382	102	37.06	17.29	0.83	16.46	170	1391	227	85.7
BTS 8555	206	335.9	99	12039	103	66.88	99	2390	103	35.85	17.57	0.78	16.79	157	1296	217	84.0
BTS 8580	208	333.8	99	11029	95	66.10	98	2177	94	33.21	17.47	0.77	16.70	153	1312	203	82.6
BTS 8598	214	343.1	101	12191	105	69.49	103	2460	106	35.83	17.91	0.74	17.17	150	1244	201	85.1
Crystal 364	226	329.8	98	12032	103	64.61	95	2349	101	36.61	17.34	0.84	16.50	185	1470	208	84.8
Crystal 470	213	330.1	98	13053	112	64.73	96	2552	110	39.61	17.26	0.74	16.52	155	1320	184	84.0
Crystal 471	217	335.7	99	12297	106	66.81	99	2435	105	36.93	17.56	0.75	16.81	163	1257	201	83.9
Crystal 580	224	339.3	100	12615	108	68.08	101	2526	109	37.18	17.72	0.76	16.96	146	1353	197	89.1
Crystal 581	227	351.4	104	12972	112	72.56	107	2666	115	37.13	18.28	0.69	17.59	138	1216	179	90.0
Crystal 583	201	335.2	99	12413	107	66.60	98	2459	106	37.12	17.48	0.71	16.77	158	1217	187	80.0
Crystal 584	204	349.1	103	12563	108	71.73	106	2579	111	36.02	18.19	0.73	17.46	149	1289	188	86.7
Crystal 591	209	340.4	101	12649	109	68.49	101	2537	109	37.40	17.86	0.82	17.04	179	1346	229	86.9
Crystal 594	203	344.7	102	12431	107	70.07	104	2521	108	36.21	17.96	0.72	17.24	161	1231	186	81.3
Hilleshög HIL2493	220	323.6	96	12098	104	62.32	92	2326	100	37.55	16.95	0.76	16.19	178	1265	205	88.8
Hilleshög HIL2494	229	326.5	97	11011	95	63.39	94	2123	91	34.09	17.16	0.81	16.35	172	1396	209	83.0
Hilleshög HIL2532	216	336.5	100	11159	96	67.09	99	2222	96	33.24	17.59	0.76	16.83	149	1290	204	86.5
Hilleshög HIL2533	218	327.7	97	12625	109	63.82	94	2446	105	38.85	17.19	0.79	16.40	142	1398	202	82.0
Hilleshög HIL2534	221	331.7	98	10811	93	65.31	97	2117	91	32.78	17.42	0.81	16.61	151	1372	227	86.4
Hilleshög HIL2535	205	338.8	100	12366	106	67.90	100	2471	106	36.69	17.68	0.73	16.95	142	1308	180	81.4
SV 251	207	336.6	100	12147	104	67.12	99	2414	104	36.29	17.61	0.77	16.84	139	1404	189	84.6
SV 254	212	323.6	96	11352	98	62.32	92	2183	94	35.12	17.06	0.87	16.20	180	1472	236	83.4
SV 255	215	322.0	95	12374	106	61.73	91	2363	102	38.61	16.95	0.85	16.10	157	1423	236	86.4
SV 256	225	328.8	97	12755	110	64.22	95	2492	107	38.86	17.25	0.81	16.44	153	1468	202	82.6
SV 345	219	330.9	98	12807	110	65.03	96	2508	108	38.87	17.31	0.74	16.57	150	1322	188	86.9
SV 347	230	332.3	98	11338	97	65.55	97	2223	96	34.43	17.40	0.77	16.63	156	1300	207	85.1
BTS 8815 (CommBench)	231	339.9	101	11502	99	68.31	101	2301	99	33.98	17.78	0.78	17.00	163	1430	183	81.0
Crystal 803 (CommBench)	232	340.9	101	12210	105	68.68	102	2457	106	35.80	17.79	0.75	17.04	138	1362	184	83.3
BTS 8927 (CommBench)	233	337.8	100	11529	99	67.57	100	2311	99	34.16	17.72	0.83	16.89	167	1369	235	82.5
HIL2389 (CommBench)	234	333.8	99	11285	97	66.09	98	2234	96	33.80	17.43	0.74	16.69	133	1306	196	83.3
BTS 8156 (1stYearBench)	235	331.9	98	11124	96	65.39	97	2189	94	33.61	17.46	0.85	16.61	185	1483	214	80.7
AP CK MOD RES RR#7	236	314.4	93	11446	98	58.91	87	2154	93	36.21	16.51	0.81	15.70	187	1308	227	77.9
Comm Benchmark Mean		338.1		11632		67.66		2326		34.44	17.68	0.78		150	1316	198	84.8
Comm Trial Mean		333.7		11723		66.05		2318		35.15	17.47	0.79		160	1315	203	86.5
Coeff. of Var. (%)		1.9		5.2		3.5		5.8		5.1	1.7	5.0		14.7	3.7	9.6	7.9
Mean LSD (0.05)		6.0		578		2.20		127		1.70	0.29	0.04		22	45	18	5.8
Mean LSD (0.01)		7.8		762		2.90		168		2.25	0.38	0.05		29	60	24	7.6
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from St. Thomas ND — Created 09/22/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258311

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 20. 2025 Performance of Varieties - ACSC RR Official Trials
Northcote MN

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	341.3	99	9550	100	68.86	97	1929	99	27.98	18.29	1.22	17.07	160	1689	443	75.4
BTS 8034	122	329.9	95	9725	102	64.63	91	1898	97	29.63	17.92	1.42	16.50	223	2024	485	61.6
BTS 8156	118	342.2	99	9862	103	69.17	98	1996	102	28.77	18.43	1.32	17.11	183	1998	428	65.2
BTS 8226	117	344.7	99	9126	96	70.10	99	1860	95	26.39	18.52	1.29	17.23	170	1695	486	68.6
BTS 8270	116	345.1	100	9911	104	70.27	99	2021	104	28.64	18.43	1.18	17.25	158	1740	391	65.5
BTS 8365	120	352.9	102	9192	96	73.13	103	1904	98	26.06	18.90	1.25	17.65	168	1685	463	68.9
BTS 8927 (CommBench)	115	355.6	103	10017	105	74.15	105	2087	107	28.18	18.91	1.13	17.78	142	1622	392	74.4
Crystal 022	105	358.7	104	9772	102	75.28	106	2050	105	27.32	19.04	1.11	17.93	136	1613	384	78.0
Crystal 130	110	346.9	100	9694	102	70.91	100	1980	102	27.95	18.57	1.23	17.34	163	1729	432	64.8
Crystal 138	119	347.6	100	9807	103	71.16	101	2014	103	28.14	18.66	1.28	17.38	144	1701	490	69.9
Crystal 260	104	357.0	103	10363	109	74.67	106	2168	111	29.03	18.99	1.14	17.85	141	1712	378	70.4
Crystal 269	107	358.4	103	9997	105	75.18	106	2096	107	27.83	19.12	1.19	17.93	158	1785	389	65.4
Crystal 361	111	359.0	104	9956	104	75.40	107	2087	107	27.77	19.13	1.17	17.96	152	1646	416	73.5
Crystal 369	109	351.4	101	10679	112	72.58	103	2204	113	30.43	18.94	1.37	17.57	171	1845	507	75.5
Crystal 793	112	346.0	100	9896	104	70.59	100	2019	104	28.65	18.46	1.16	17.30	167	1673	395	73.3
Crystal 912	102	329.7	95	10629	111	64.57	91	2090	107	31.98	17.75	1.26	16.49	194	1768	434	77.1
Hilleshög HIL2389 (CommBench)	103	338.2	98	9405	99	67.71	96	1887	97	27.79	18.10	1.20	16.90	152	1913	363	70.7
Hilleshög HIL2479	101	341.1	98	10061	105	68.78	97	2028	104	29.46	18.25	1.19	17.06	186	1691	406	77.2
Hilleshög HIL2480	113	332.5	96	9912	104	65.61	93	1958	100	29.81	18.12	1.50	16.62	210	1871	586	72.8
Maribo MA717	121	334.7	97	9893	104	66.40	94	1962	101	29.58	18.07	1.33	16.74	191	1857	470	57.8
SX 1815	108	352.2	102	9915	104	72.88	103	2053	105	28.16	18.74	1.14	17.60	140	1835	342	64.9
SX 1835	114	337.8	97	10497	110	67.53	95	2100	108	31.01	18.22	1.33	16.89	169	1928	458	76.7
SV 231	123	336.9	97	10100	106	67.23	95	2020	104	29.84	18.13	1.29	16.84	170	1927	422	75.2
BTS 8815 (CommBench)	124	346.3	100	9434	99	70.69	100	1927	99	27.33	18.58	1.27	17.31	190	1883	414	75.4
Crystal 803 (CommBench)	125	345.8	100	9300	97	70.51	100	1900	97	26.81	18.57	1.28	17.29	159	1790	456	77.8
AP CK MOD RES RR#7	126	338.4	98	10795	113	67.77	96	2166	111	31.84	18.16	1.24	16.92	192	1742	427	77.8
AP CK MOD SUS RR#8	127	348.9	101	9595	101	71.66	101	1975	101	27.39	18.63	1.18	17.45	151	1669	419	67.7
Experimental Trial (Comm status)																	
BTS 8440	222	361.8	104	9688	102	76.27	108	2050	105	26.63	19.11	1.03	18.09	132	1601	278	78.1
BTS 8457	202	355.2	103	9679	101	73.89	104	2009	103	27.42	18.75	1.00	17.76	138	1483	283	76.6
BTS 8509	211	348.4	101	9996	105	71.47	101	2055	105	28.59	18.54	1.13	17.41	146	1561	355	74.0
BTS 8513	210	342.8	99	9720	102	69.45	98	1966	101	28.48	18.56	1.42	17.14	158	1959	462	71.0
BTS 8520	223	337.5	97	9962	104	67.52	95	2005	103	29.43	18.05	1.20	16.86	158	1704	367	70.2
BTS 8531	228	351.3	101	10085	106	72.49	102	2083	107	28.90	18.75	1.22	17.54	156	1731	369	81.3
BTS 8555	206	355.3	103	9013	94	73.93	104	1880	96	25.54	18.95	1.16	17.78	156	1662	357	75.3
BTS 8580	208	348.1	100	8632	90	71.36	101	1764	90	24.97	18.59	1.21	17.38	149	1694	375	72.8
BTS 8598	214	362.1	105	9686	102	76.39	108	2042	105	26.97	19.19	1.08	18.11	125	1614	321	78.1
Crystal 364	226	341.8	99	10048	105	69.06	98	2033	104	29.50	18.31	1.23	17.08	165	1771	367	87.9
Crystal 470	213	328.7	95	9381	98	64.38	91	1844	95	28.54	17.67	1.25	16.42	168	1737	394	81.0
Crystal 471	217	359.8	104	9152	96	75.56	107	1932	99	25.29	19.09	1.08	18.01	142	1627	312	66.7
Crystal 580	224	354.7	102	9780	103	73.73	104	2025	104	27.86	18.88	1.15	17.73	150	1726	329	78.4
Crystal 581	227	359.9	104	8956	94	75.58	107	1879	96	25.03	19.11	1.12	17.99	144	1696	318	65.9
Crystal 583	201	344.4	99	9616	101	70.01	99	1959	100	28.11	18.39	1.18	17.22	169	1700	348	70.8
Crystal 584	204	359.6	104	9698	102	75.50	107	2029	104	27.07	19.13	1.15	17.98	143	1634	355	73.1
Crystal 591	209	355.3	103	9390	98	73.95	104	1962	101	26.46	18.96	1.16	17.79	172	1628	361	73.3
Crystal 594	203	356.3	103	9840	103	74.30	105	2049	105	27.79	18.85	1.01	17.84	151	1559	271	74.5
Hilleshög HIL2493	220	346.8	100	10591	111	70.88	100	2163	111	30.55	18.55	1.23	17.32	157	1851	342	81.0
Hilleshög HIL2494	229	334.4	97	9481	99	66.41	94	1889	97	28.36	18.06	1.35	16.71	149	1915	431	72.8
Hilleshög HIL2532	216	344.5	99	9625	101	70.05	99	1962	101	27.87	18.40	1.19	17.22	148	1757	344	75.5
Hilleshög HIL2533	218	339.8	98	10422	109	68.37	97	2083	107	30.90	18.23	1.25	16.98	143	1853	373	81.9
Hilleshög HIL2534	221	345.8	100	10157	106	70.53	100	2063	106	29.40	18.56	1.30	17.26	144	1838	411	61.5
Hilleshög HIL2535	205	345.1	100	9627	101	70.29	99	1953	100	28.09	18.44	1.19	17.26	168	1812	332	72.7
SV 251	207	340.3	98	10097	106	68.55	97	2032	104	29.82	18.38	1.41	16.98	158	2024	433	79.3
SV 254	212	336.7	97	9623	101	67.22	95	1918	98	28.79	18.11	1.30	16.81	173	1919	380	66.6
SV 255	215	332.2	96	9808	103	65.62	93	1932	99	29.51	17.84	1.24	16.60	157	1858	360	71.0
SV 256	225	339.2	98	10007	105	68.13	96	1996	102	30.01	18.18	1.25	16.93	161	1868	363	63.0
SV 345	219	345.0	100	10186	107	70.21	99	2073	106	29.56	18.49	1.24	17.25	154	1879	347	69.5
SV 347	230	350.7	101	9740	102	72.31	102	2003	103	27.70	18.81	1.27	17.54	144	1837	385	64.1
BTS 8815 (CommBench)	231	345.2	100	9252	97	70.32	99	1891	97	26.70	18.55	1.27	17.28	169	1861	375	64.8
Crystal 803 (CommBench)	232	343.9	99	10177	107	69.84	99	2077	107	29.58	18.44	1.25	17.19	148	1718	405	79.0
BTS 8927 (CommBench)	233	349.0	101	9456	99	71.67	101	1931	99	27.35	18.58	1.16	17.41	144	1636	364	74.1
HIL2389 (CommBench)	234	347.8	100	9271	97	71.22	101	1903	98	26.48	18.59	1.20	17.39	135	1827	341	72.9
BTS 8156 (1stYearBench)	235	348.1	100	9811	103	71.36	101	2018	103	28.20	18.61	1.21	17.40	160	1925	311	73.1
AP CK MOD RES RR#7	236	329.5	95	10790	113	64.64	91	2126	109	32.83	17.76	1.31	16.45	176	1700	445	75.3
Comm Benchmark Mean		346.5		9539		70.77		1950		27.53	18.54	1.22		161	1802	406	74.6
Comm Trial Mean		345.2		9892		70.27		2014		28.66	18.50	1.25		168	1779	432	71.2
Coeff. of Var. (%)		2.7		7.2		4.9		8.1		6.8	2.1	9.6		13.6	4.1	17.5	17.0
Mean LSD (0.05)		8.8		663		3.27		155		1.80	0.36	0.11		21	68	72	10.5
Mean LSD (0.01)		11.6		873		4.31		204		2.37	0.48	0.15		28	89	94	13.8
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Northcote MN — Created 10/01/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs. — Trial # = 258312

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 21. 2025 Performance of Varieties - ACSC RR Official Trials
Bathgate ND

Description @	Code	Rec/T lbs.	%Bnch	Rec/A lbs.	%Bnch	Rev/T $ +	%Bnch	Rev/A $ +	%Bnch	Yield T/A	Sugar% Gross	Sugar% LTM	Sugar% Rec	Na ppm	K ppm	AmN ppm	Emerg. %
Commercial Trial																	
BTS 8018	106	320.8	98	11616	99	61.27	96	2222	97	36.10	16.99	0.94	16.05	204	1473	266	64.9
BTS 8034	122	320.4	98	11993	102	61.13	96	2288	100	37.41	17.06	1.04	16.02	225	1759	259	49.8
BTS 8156	118	315.5	96	11401	97	59.28	93	2134	93	36.17	16.75	0.97	15.78	218	1714	218	48.9
BTS 8226	117	336.4	103	11689	99	67.02	105	2334	102	34.72	17.68	0.87	16.81	182	1434	225	55.2
BTS 8270	116	332.4	101	11617	99	65.55	103	2298	100	34.97	17.52	0.90	16.62	183	1587	212	53.6
BTS 8365	120	343.9	105	11107	94	69.79	109	2247	98	32.44	18.03	0.84	17.19	184	1469	191	53.8
BTS 8927 (CommBench)	115	325.2	99	11448	97	62.87	98	2216	97	34.99	17.24	0.98	16.26	204	1497	284	55.4
Crystal 022	105	337.4	103	11795	100	67.39	105	2354	103	35.00	17.72	0.85	16.87	162	1386	231	51.6
Crystal 130	110	337.0	103	11811	100	67.26	105	2351	103	35.26	17.76	0.91	16.85	192	1521	230	53.2
Crystal 138	119	341.3	104	12252	104	68.85	108	2468	108	35.86	17.98	0.91	17.07	164	1483	253	51.2
Crystal 260	104	323.0	98	11900	101	62.08	97	2287	100	36.82	17.08	0.93	16.15	200	1577	228	54.2
Crystal 269	107	345.8	105	12606	107	70.50	110	2567	112	36.61	18.25	0.96	17.29	182	1644	246	56.8
Crystal 361	111	340.7	104	11992	102	68.63	107	2415	105	35.34	17.93	0.90	17.03	167	1490	240	58.5
Crystal 369	109	330.5	101	12119	103	64.85	101	2376	104	36.62	17.58	1.05	16.53	230	1673	287	55.2
Crystal 793	112	328.0	100	11972	102	63.92	100	2332	102	36.37	17.32	0.92	16.40	188	1473	250	60.3
Crystal 912	102	309.8	94	12001	102	57.18	89	2215	97	38.76	16.57	1.08	15.49	297	1512	324	60.7
Hilleshög HIL2389 (CommBench)	103	332.8	101	11860	101	65.72	103	2343	102	35.82	17.53	0.89	16.64	161	1553	224	54.7
Hilleshög HIL2479	101	335.5	102	12411	105	66.68	104	2474	108	36.95	17.67	0.90	16.77	214	1475	227	56.4
Hilleshög HIL2480	113	324.6	99	12052	102	62.67	98	2334	102	37.19	17.35	1.11	16.24	255	1609	342	51.2
Maribo MA717	121	315.5	96	12264	104	59.29	93	2304	100	38.87	16.77	0.99	15.78	266	1611	245	52.4
SX 1815	108	331.3	101	11837	101	65.14	102	2329	102	35.75	17.56	0.99	16.57	210	1714	239	49.3
SX 1835	114	323.4	99	12704	108	62.23	97	2441	106	39.29	17.16	0.99	16.17	210	1664	252	54.2
SV 231	123	317.5	97	12358	105	60.05	94	2342	102	38.81	16.89	1.02	15.87	224	1685	260	57.6
BTS 8815 (CommBench)	124	334.7	102	11933	101	66.41	104	2371	103	35.48	17.84	1.11	16.73	213	1820	296	51.0
Crystal 803 (CommBench)	125	319.2	97	11835	101	60.65	95	2243	98	37.12	16.90	0.94	15.96	189	1568	246	60.0
AP CK MOD RES RR#7	126	314.9	96	12268	104	59.08	92	2303	100	38.80	16.71	0.96	15.75	252	1516	250	63.7
AP CK MOD SUS RR#8	127	332.8	101	11618	99	65.72	103	2296	100	34.93	17.54	0.90	16.64	203	1472	231	56.9
Experimental Trial (Comm status)																	
BTS 8440	222	331.1	101	12591	107	65.03	102	2472	108	38.00	17.47	0.91	16.56	169	1430	205	61.2
BTS 8457	202	336.2	103	11961	102	66.88	105	2381	104	35.53	17.69	0.87	16.82	167	1361	200	55.2
BTS 8509	211	333.2	102	12069	103	65.81	103	2380	104	36.23	17.54	0.86	16.67	152	1379	188	53.8
BTS 8513	210	324.8	99	11255	96	62.77	98	2174	95	34.62	17.32	1.09	16.23	203	1751	236	48.0
BTS 8520	223	325.6	99	12672	108	63.04	99	2452	107	39.07	17.26	0.99	16.27	189	1583	217	55.1
BTS 8531	228	322.5	98	12054	102	61.95	97	2306	101	37.48	17.15	1.03	16.12	212	1570	233	48.9
BTS 8555	206	322.3	98	10848	92	61.87	97	2078	91	33.69	17.10	0.98	16.11	169	1453	248	61.9
BTS 8580	208	334.6	102	11264	96	66.30	104	2233	97	33.63	17.69	0.95	16.74	163	1471	223	59.6
BTS 8598	214	325.0	99	11646	99	62.86	98	2256	98	35.80	17.22	0.97	16.25	185	1535	219	50.0
Crystal 364	226	319.5	97	12018	102	60.87	95	2284	100	37.73	17.03	1.07	15.96	230	1648	239	52.4
Crystal 470	213	323.9	99	12545	107	62.48	98	2414	105	38.93	17.12	0.93	16.19	150	1502	211	55.9
Crystal 471	217	328.2	100	12408	105	64.00	100	2418	105	37.89	17.35	0.94	16.41	157	1464	219	53.7
Crystal 580	224	328.2	100	12585	107	64.01	100	2452	107	38.43	17.36	0.95	16.41	171	1554	200	55.2
Crystal 581	227	326.7	100	11645	99	63.47	99	2258	98	35.63	17.29	0.96	16.33	193	1453	224	50.2
Crystal 583	201	322.8	98	11744	100	62.04	97	2256	98	36.44	17.00	0.85	16.15	167	1426	163	61.1
Crystal 584	204	339.6	104	11832	101	68.11	107	2371	103	34.90	17.97	0.99	16.97	192	1501	236	54.9
Crystal 591	209	340.5	104	12199	104	68.41	107	2449	107	35.85	17.91	0.87	17.03	149	1392	195	57.4
Crystal 594	203	331.2	101	12614	107	65.06	102	2479	108	38.09	17.50	0.93	16.57	158	1450	219	57.9
Hilleshög HIL2493	220	318.1	97	12582	107	60.38	94	2388	104	39.58	16.88	0.98	15.90	194	1631	195	49.0
Hilleshög HIL2494	229	312.1	95	12394	105	58.22	91	2311	101	39.62	16.73	1.14	15.59	222	1664	285	54.7
Hilleshög HIL2532	216	319.1	97	11722	100	60.71	95	2230	97	36.63	16.96	1.00	15.96	191	1595	219	52.7
Hilleshög HIL2533	218	316.6	97	13041	111	59.79	94	2468	108	41.17	16.79	0.96	15.82	174	1533	206	52.9
Hilleshög HIL2534	221	331.4	101	12340	105	65.16	102	2425	106	37.35	17.60	1.05	16.56	151	1675	247	52.7
Hilleshög HIL2535	205	318.5	97	11743	100	60.52	95	2226	97	37.00	16.92	1.02	15.91	183	1553	235	52.6
SV 251	207	329.5	100	12560	107	64.46	101	2461	107	38.03	17.51	1.03	16.48	169	1735	213	53.9
SV 254	212	310.1	95	12092	103	57.46	90	2241	98	38.93	16.56	1.07	15.49	252	1656	225	57.0
SV 255	215	316.9	97	12684	108	59.95	94	2399	105	39.98	16.84	0.99	15.85	184	1624	209	46.3
SV 256	225	318.4	97	12535	107	60.47	95	2378	104	39.52	16.90	1.00	15.90	166	1607	225	47.4
SV 345	219	315.5	96	12571	107	59.42	93	2367	103	39.77	16.79	1.03	15.77	208	1701	202	58.1
SV 347	230	331.7	101	11981	102	65.26	102	2353	103	36.27	17.54	0.96	16.58	144	1614	197	54.4
BTS 8815 (CommBench)	231	321.8	98	11454	97	61.68	97	2197	96	35.49	17.10	1.00	16.09	173	1724	195	51.3
Crystal 803 (CommBench)	232	323.7	99	10912	93	62.39	98	2103	92	33.68	17.18	0.99	16.18	186	1543	230	60.8
BTS 8927 (CommBench)	233	339.7	104	12380	105	68.14	107	2478	108	36.59	17.90	0.92	16.98	142	1475	205	55.9
HIL2389 (CommBench)	234	326.6	100	12330	105	63.44	99	2395	104	37.65	17.34	1.00	16.34	177	1635	214	44.9
BTS 8156 (1stYearBench)	235	325.0	99	11551	98	62.83	98	2226	97	35.65	17.20	0.96	16.24	168	1623	193	49.3
AP CK MOD RES RR#7	236	313.6	96	13220	112	58.73	92	2471	108	42.24	16.66	0.99	15.66	212	1468	240	60.1
Comm Benchmark Mean		328.0		11769		63.91		2293		35.85	17.38	0.98		192	1610	262	55.3
Comm Trial Mean		328.5		11943		64.12		2329		36.39	17.38	0.96		207	1570	250	55.2
Coeff. of Var. (%)		3.0		5.3		5.6		6.9		4.7	2.6	7.6		17.0	4.0	15.9	16.9
Mean LSD (0.05)		9.0		552		3.32		145		1.44	0.41	0.07		32	59	37	8.3
Mean LSD (0.01)		11.8		727		4.38		191		1.89	0.55	0.09		42	77	49	10.9
Sig Lvl		**		**		**		**		**	**	**		**	**	**	**

2025 Data from Bathgate ND

Created 10/02/2025

@ 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 $60.97 beet payment at 17.5% sugar & 1.5% loss to molasses and do not consider hauling costs.

Trial # = 258313

Na, K, AmN, and Emergence not adjusted to commercial status.

Table 22. Calculation for Approval of Sugarbeet Varieties for ACSC Market for 2026

Approval Description	Status	Rec/Ton 2024	Rec/Ton 2025	Rec/Ton 2 Yr	Rec/Ton % Bench	Rev/Acre++ 2024	Rev/Acre++ 2025	Rev/Acre++ 2 Yr	Rev/Acre++ % Bench	R/T + $/A % Bench	Cercospora Rating ^ 2023	Cercospora Rating ^ 2024	Cercospora Rating ^ 2025	Cercospora Rating ^ 2 Yr Mean	Cercospora Rating ^ 3 Yr Mean
Previously Approved (3 Yr)															**<=5.30**
BTS 8018	Approved	336.0	324.3	330.2	99.2	2101	2179	2140	102.2	201.4	2.42	3.35	3.88	3.62	3.22
BTS 8034	Approved	324.1	314.0	319.1	95.9	1978	2051	2015	96.2	192.0	2.54	3.69	4.28	3.99	3.51
BTS 8156	Approved	331.8	323.9	327.9	98.5	2015	2130	2073	98.9	197.4	2.53	3.87	4.38	4.12	3.59
BTS 8226	Approved	346.2	335.9	341.1	102.5	2146	2256	2201	105.1	207.5	2.33	3.52	4.05	3.79	3.30
BTS 8270	Approved	337.5	333.1	335.3	100.7	2064	2189	2127	101.5	202.3	2.43	3.32	3.56	3.44	3.10
BTS 8365	Approved	350.3	338.7	344.5	103.5	2088	2151	2120	101.2	204.7	4.15	4.18	3.95	4.07	4.10
BTS 8927	Approved	345.0	333.0	339.0	101.8	2124	2215	2170	103.6	205.4	4.38	4.45	4.22	4.34	4.35
Crystal 022	Approved	344.0	336.4	340.2	102.2	2044	2216	2130	101.7	203.9	4.97	4.66	4.78	4.72	4.81
Crystal 130	Approved	337.5	330.8	334.2	100.4	2077	2213	2145	102.4	202.8	2.60	3.56	4.27	3.92	3.48
Crystal 138	Approved	333.8	331.7	332.8	100.0	2024	2216	2120	101.2	201.2	4.77	4.73	4.47	4.60	4.66
Crystal 260	Approved	340.2	330.7	335.5	100.8	2124	2219	2172	103.7	204.4	2.15	3.13	3.60	3.37	2.96
Crystal 269	Approved	345.0	333.0	339.0	101.8	2139	2253	2196	104.8	206.7	4.38	4.54	4.42	4.48	4.45
Crystal 361	Approved	339.9	337.2	338.6	101.7	2119	2282	2201	105.1	206.8	2.24	3.33	3.71	3.52	3.09
Crystal 364	Approved	327.7	317.6	322.7	96.9	2081	2162	2122	101.3	198.2	4.26	4.46	4.37	4.41	4.36
Crystal 369	Approved	338.3	326.6	332.5	99.9	2101	2214	2158	103.0	202.9	3.78	4.03	3.88	3.96	3.90
Crystal 793	Approved	338.8	328.2	333.5	100.2	2092	2220	2156	102.9	203.1	4.20	4.28	3.98	4.13	4.15
Crystal 912	Approved	316.4	311.9	314.2	94.4	2035	2174	2105	100.5	194.8	5.00	5.06	5.04	5.05	5.03
Hilleshög HIL2389	Approved	336.9	326.0	331.5	99.6	2062	2116	2089	99.7	199.3	4.51	4.57	4.53	4.55	4.54
Hilleshög HIL2479	Approved	338.3	324.7	331.5	99.6	1868	2067	1968	93.9	193.5	4.09	4.25	4.21	4.23	4.18
Hilleshög HIL2480	Specialty	331.3	319.8	325.6	97.8	1886	2052	1969	94.0	191.8	4.00	4.08	4.24	4.16	4.11
Maribo MA717	Approved	323.9	316.2	320.1	96.2	1978	2065	2022	96.5	192.7	5.04	4.85	4.82	4.83	4.90
SX 1815	Approved	337.7	324.6	331.2	99.5	2070	2097	2084	99.5	199.0	4.74	4.70	4.74	4.72	4.73
SX 1835	Specialty	324.4	317.2	320.8	96.4	2060	2160	2110	100.7	197.1	4.55	4.66	4.60	4.63	4.60
SV 231	Approved	326.2	319.5	322.9	97.0	2116	2179	2148	102.5	199.5	4.83	4.77	4.73	4.75	4.78
Candidates for Approval (2 Yr)														**<=5.00**	
BTS 8440	Approved	341.6	338.7	340.2	102.2	2105	2290	2198	104.9	207.1	--	2.90	3.18	3.04	--
BTS 8457	Approved	341.9	333.0	337.5	101.4	2159	2228	2194	104.7	206.1	--	3.55	4.07	3.81	--
Crystal 470	Approved	332.6	325.9	329.3	98.9	2145	2247	2196	104.8	203.8	--	3.71	4.21	3.96	--
Crystal 471	Approved	343.7	335.9	339.8	102.1	2157	2251	2204	105.2	207.3	--	3.49	4.10	3.79	--
Hilleshög HIL2493	Not Approved	328.1	317.7	322.9	97.0	2149	2164	2157	102.9	200.0	--	4.82	4.65	4.74	--
Hilleshög HIL2494	Not Approved	332.7	316.1	324.4	97.5	2123	2101	2112	100.8	198.3	--	4.60	4.70	4.65	--
SV 345	Not Approved	321.8	318.4	320.1	96.2	2129	2147	2138	102.1	198.2	--	4.93	4.84	4.89	--
SV 347	Not Approved	336.5	325.8	331.2	99.5	2085	2101	2093	99.9	199.4	--	4.81	4.73	4.77	--

Benchmark Varieties		2023	2024	2025			2023	2024	2025		
Crystal 578RR (Check)	Benchmark	346.1					1907				
BTS 8815 (CommBench)	Benchmark	344.7	332.0	328.2			1703	2009	2095		
Crystal 803 (CommBench)	Benchmark	350.5	337.1	327.2			2003	2044	2174		
BTS 8927 (CommBench)	Benchmark	356.0	343.5	333.0			1897	2018	2215		
HIL2389 (CommBench)	Benchmark		335.8	326.0				2087	2116		
					2yr	3yr				2yr	3yr
Benchmark mean		349.3	337.1	328.6	332.9	338.3	1878	2039	2150	2095	2022

Variety approval criteria include: 1) Two years of official trial data, 2) Cercospora rating must not exceed 5.00 (1982 adjusted data), AND

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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.

"Specialty" = Does not meet full market approval. Meets Aphanomyces and/or Rhizoctonia Specialty approval.

To maintain approval, the three-year Cercospora rating must not exceed 5.30 (1982 adjusted data).

++2025 Revenue estimate based on a $60.97 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses and 2024 Revenue estimate based on a $54.53 beet payment.

Revenue does not consider hauling or production costs.

^ All Cercospora ratings 2023-2025 were adjusted to 1982 basis.

Table 23. 2025 First Year Experimental Varieties
New Benchmark Comparison
Projected Calculation for Approval of Sugarbeet Varieties for ACSC Market

Description	Approval ^ Likely	Rec/Ton 2025	Rec/Ton % Bench	Rev/Acre ++ 2025	Rev/Acre ++ % Bench	R/T + $/A % Bench	CR Rating ^^ 2025
Candidates for Retesting (1 Yr)							
BTS 8509	On Track	334.5	101.8	2244	104.5	206.3	3.73
BTS 8513	Not On Track	325.4	99.1	2101	97.8	196.9	3.63
BTS 8520	On Track	326.2	99.3	2242	104.4	203.7	3.71
BTS 8531	Not On Track	323.3	98.4	2217	103.2	201.7	4.12
BTS 8555	On Track	329.8	100.4	2136	99.5	199.9	3.88
BTS 8580	On Track	332.0	101.1	2054	95.6	196.7	3.00
BTS 8598	On Track	337.4	102.7	2262	105.3	208.0	3.54
Crystal 580	On Track	328.5	100.0	2208	102.8	202.8	4.07
Crystal 581	On Track	338.6	103.1	2270	105.7	208.8	3.86
Crystal 583	Not On Track	325.3	99.0	2185	101.7	200.8	4.37
Crystal 584	On Track	339.1	103.2	2254	105.0	208.2	3.85
Crystal 591	On Track	339.3	103.3	2307	107.4	210.7	3.24
Crystal 594	On Track	336.2	102.4	2312	107.7	210.0	4.75
Hilleshög HIL2532	Not On Track	322.8	98.3	2030	94.5	192.8	4.67
Hilleshög HIL2533	Not On Track	317.9	96.8	2159	100.5	197.3	4.80
Hilleshög HIL2534	Not On Track	320.5	97.6	2026	94.3	191.9	4.55
Hilleshög HIL2535	Not On Track	326.4	99.4	2145	99.9	199.3	4.84
SV 251	On Track	326.3	99.3	2226	103.7	203.0	4.64
SV 254	Not On Track	319.6	97.3	2118	98.6	195.9	4.28
SV 255	Not On Track	317.6	96.7	2155	100.3	197.0	4.56
SV 256	Not On Track	319.1	97.1	2112	98.3	195.5	4.58
Benchmarks *							
Crystal 803 (CommBench)		328.8	100.1	2183	101.6		
BTS 8927 (CommBench)		335.4	102.1	2231	103.9		
HIL2389 (CommBench)		324.6	98.8	2091	97.4		
BTS 8156 (1stYearBench)		325.1	99.0	2085	97.1		
Benchmark Mean		328.5		2148			

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.

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++2025 Revenue estimate based on a $60.97 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses.

Revenue does not consider hauling or production cost

* 2025 benchmark varieties for first year entries dropped BTS 8815 and added BTS 8156

^^ All Cercospora ratings from 2025 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 2026

Description	Approval Status	Aphanomyces Root Rating 2023	2024	2025	2 Yr	3 Yr	Cercospora Rating * 2023	2024	2025	2 Yr	3 Yr
Previously Approved (3 Yr)						**<=4.30**				**<=5.30**	
BTS 8018	Approved	3.95	3.73	3.51	3.62	3.73	2.42	3.35	3.88	3.62	3.22
BTS 8034	Approved	3.80	4.48	3.52	4.00	3.93	2.54	3.69	4.28	3.99	3.51
BTS 8156	Approved	3.97	4.27	3.59	3.93	3.94	2.53	3.87	4.38	4.12	3.59
BTS 8226	Approved	3.72	3.81	3.43	3.62	3.65	2.33	3.52	4.05	3.79	3.30
BTS 8270	Approved	3.90	3.76	3.61	3.69	3.76	2.43	3.32	3.56	3.44	3.10
BTS 8365	Approved	3.62	3.87	3.69	3.78	3.73	4.15	4.18	3.95	4.07	4.10
BTS 8927	Approved	3.26	4.41	3.67	4.04	3.78	4.38	4.45	4.22	4.34	4.35
Crystal 022	Approved	3.66	3.95	3.33	3.64	3.65	4.97	4.66	4.78	4.72	4.81
Crystal 130	Approved	4.00	3.72	3.46	3.59	3.73	2.60	3.56	4.27	3.92	3.48
Crystal 138	Approved	4.06	3.84	3.56	3.70	3.82	4.77	4.73	4.47	4.60	4.66
Crystal 260	Approved	3.84	4.08	3.58	3.83	3.83	2.15	3.13	3.60	3.37	2.96
Crystal 269	Approved	3.62	3.50	3.07	3.29	3.40	4.38	4.54	4.42	4.48	4.45
Crystal 361	Approved	3.45	3.80	3.13	3.47	3.46	2.24	3.33	3.71	3.52	3.09
Crystal 364	Approved	3.79	3.78	3.38	3.58	3.65	4.26	4.46	4.37	4.41	4.36
Crystal 369	Approved	4.02	3.45	3.35	3.40	3.61	3.78	4.03	3.88	3.96	3.90
Crystal 793	Approved	4.31	3.72	3.17	3.45	3.73	4.20	4.28	3.98	4.13	4.15
Crystal 912	Approved	3.41	3.57	3.27	3.42	3.42	5.00	5.06	5.04	5.05	5.03
Hilleshög HIL2389	Approved	5.42	3.56	3.80	3.68	4.26	4.51	4.57	4.53	4.55	4.54
Candidates for Approval (2 Yr)					**<=4.00**					**<=5.00**	
BTS 8440	Approved	--	4.03	3.61	3.82	--	--	2.90	3.18	3.04	--
BTS 8457	Not Approved	--	4.33	3.96	4.15	--	--	3.55	4.07	3.81	--
Crystal 470	Approved	--	3.67	3.74	3.71	--	--	3.71	4.21	3.96	--
Crystal 471	Approved	--	3.99	3.62	3.81	--	--	3.49	4.10	3.79	--
Hilleshög HIL2479	Not Approved	4.38	4.76	4.18	4.47	4.44	4.09	4.25	4.21	4.23	4.18
Hilleshög HIL2480	Not Approved	4.30	4.43	4.06	4.25	4.26	4.00	4.08	4.24	4.16	4.11
Hilleshög HIL2493	Not Approved	--	4.15	4.27	4.21	--	--	4.82	4.65	4.74	--
Hilleshög HIL2494	Not Approved	--	4.10	4.13	4.11	--	--	4.60	4.70	4.65	--
Maribo MA717	Not Approved	4.61	4.18	4.88	4.53	4.55	5.04	4.85	4.82	4.83	4.90
SX 1815	Not Approved	6.15	3.96	4.28	4.12	4.80	4.74	4.70	4.74	4.72	4.73
SX 1835	Not Approved	5.99	4.31	4.43	4.37	4.91	4.55	4.66	4.60	4.63	4.60
SV 231	Not Approved	6.25	4.43	4.11	4.27	4.93	4.83	4.77	4.73	4.75	4.78
SV 345	Not Approved	--	4.20	4.12	4.16	--	--	4.93	4.84	4.89	--
SV 347	Not Approved	--	4.22	4.13	4.18	--	--	4.81	4.73	4.77	--
Approval Criteria new varieties					4.00					5.00	
Criteria to Maintain Approval						4.30					5.30

* All Cercospora ratings 2023-2025 were adjusted to 1982 basis.

Created 10/20/2025

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 2026.

Table 25. Calculation for Approval of Sugarbeet Varieties for ACSC Rhizoctonia Specialty Market for 2026

Description	Approval Status	Rhizoctonia Root Rating + 2023	2024	2025	2 Yr Mn	3 Yr Mn	Cercospora Rating 2023	2024	2025	2 Yr Mn	3 Yr Mn
Previously Approved (3 Yr)						**<=4.12**				**<=5.30**	
BTS 8226	Approved	3.78	3.46	3.64	3.55	3.62	2.33	3.52	4.05	3.79	3.30
BTS 8270	Approved	3.67	3.86	3.85	3.85	3.79	2.43	3.32	3.56	3.44	3.10
BTS 8365	Approved	3.69	3.60	3.73	3.67	3.67	4.15	4.18	3.95	4.07	4.10
BTS 8927	Approved	3.98	3.57	3.87	3.72	3.81	4.38	4.45	4.22	4.34	4.35
Crystal 022	Approved	3.85	3.63	3.87	3.75	3.78	4.97	4.66	4.78	4.72	4.81
Crystal 130	Approved	3.69	3.54	3.79	3.67	3.67	2.60	3.56	4.27	3.92	3.48
Crystal 138	Approved	3.81	3.68	3.77	3.73	3.76	4.77	4.73	4.47	4.60	4.66
Crystal 260	Approved	3.46	3.70	3.80	3.75	3.65	2.15	3.13	3.60	3.37	2.96
Crystal 361	Approved	3.54	3.78	3.99	3.88	3.77	2.24	3.33	3.71	3.52	3.09
Crystal 364	Approved	3.79	3.77	3.60	3.69	3.72	4.26	4.46	4.37	4.41	4.36
Crystal 912	Approved	3.50	3.45	3.12	3.29	3.36	5.00	5.06	5.04	5.05	5.03
Hilleshög HIL2480	Approved	3.70	3.65	3.37	3.51	3.57	4.00	4.08	4.24	4.16	4.11
SX 1835	Approved	3.55	4.07	3.79	3.93	3.80	4.55	4.66	4.60	4.63	4.60
SV 231	Approved	3.69	3.71	3.81	3.76	3.74	4.83	4.77	4.73	4.75	4.78
Candidates for Approval (2 Yr)					**<=3.82**					**<=5.00**	
BTS 8018	Approved	4.06	3.68	3.83	3.75	3.86	2.42	3.35	3.88	3.62	3.22
BTS 8034	Not Approved	4.09	4.38	4.20	4.29	4.22	2.54	3.69	4.28	3.99	3.51
BTS 8156	Not Approved	3.93	4.28	4.38	4.33	4.20	2.53	3.87	4.38	4.12	3.59
BTS 8440	Approved	--	3.68	3.82	3.75	--	--	2.90	3.18	3.04	--
BTS 8457	Approved	--	3.71	3.76	3.74	--	--	3.55	4.07	3.81	--
Crystal 269	Not Approved	3.90	4.30	4.06	4.18	4.09	4.38	4.54	4.42	4.48	4.45
Crystal 369	Not Approved	3.98	4.72	4.27	4.49	4.32	3.78	4.03	3.88	3.96	3.90
Crystal 470	Approved	--	3.85	3.78	3.82	--	--	3.71	4.21	3.96	--
Crystal 471	Approved	--	3.69	3.86	3.77	--	--	3.49	4.10	3.79	--
Crystal 793	Not Approved	4.35	3.89	4.18	4.04	4.14	4.20	4.28	3.98	4.13	4.15
Hilleshög HIL2389	Not Approved	4.45	4.08	4.01	4.04	4.18	4.51	4.57	4.53	4.55	4.54
Hilleshög HIL2479	Not Approved	3.43	4.24	3.50	3.87	3.72	4.09	4.25	4.21	4.23	4.18
Hilleshög HIL2493	Approved	--	3.83	3.56	3.69	--	--	4.82	4.65	4.74	--
Hilleshög HIL2494	Not Approved	--	3.97	3.93	3.95	--	--	4.60	4.70	4.65	--
Maribo MA717	Not Approved	4.10	4.19	3.90	4.05	4.07	5.04	4.85	4.82	4.83	4.90
SX 1815	Not Approved	4.35	4.30	4.09	4.20	4.25	4.74	4.70	4.74	4.72	4.73
SV 345	Approved	--	3.48	3.59	3.54	--	--	4.93	4.84	4.89	--
SV 347	Not Approved	--	4.28	4.02	4.15	--	--	4.81	4.73	4.77	--
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 10/20/2025

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 2026.

Table 26. 2025 Aphanomyces Ratings for Official Trial Entries
KWS (Shakopee, MN) - UBS (Glyndon, MN)

			Unadjusted				Adjusted ++									
Chk	Code	Description	Perl NA	Alva NA	Shak[Z] 8/26	Glyn 8/28	Perl NA	Alva NA	Shak[Z] 8/26	Glyn 8/28	2025	2 Yr	3 Yr	2024++	2023++	Trial Yrs $$
534	BTS 8018		--	--	3.25	2.90	--	--	3.25	3.78	3.51	3.62	3.73	3.73	3.95	6
506	BTS 8034		--	--	2.67	3.35	--	--	2.67	4.37	3.52	4.00	3.93	4.48	3.80	6
529	BTS 8156		--	--	3.14	3.10	--	--	3.14	4.04	3.59	3.93	3.94	4.27	3.97	5
504	BTS 8226		--	--	2.69	3.20	--	--	2.69	4.17	3.43	3.62	3.65	3.81	3.72	4
549	BTS 8270		--	--	3.28	3.03	--	--	3.28	3.95	3.61	3.69	3.76	3.76	3.90	4
505	BTS 8365		--	--	3.18	3.22	--	--	3.18	4.20	3.69	3.78	3.73	3.87	3.62	3
511	BTS 8440		--	--	3.27	3.03	--	--	3.27	3.95	3.61	3.82	--	4.03	--	2
518	BTS 8457		--	--	3.83	3.14	--	--	3.83	4.09	3.96	4.15	--	4.33	--	2
540	BTS 8509		--	--	3.85	2.69	--	--	3.85	3.51	3.68	--	--	--	--	1
547	BTS 8513		--	--	3.12	3.24	--	--	3.12	4.22	3.67	--	--	--	--	1
502	BTS 8520		--	--	3.81	3.00	--	--	3.81	3.91	3.86	--	--	--	--	1
543	BTS 8531		--	--	3.22	2.57	--	--	3.22	3.35	3.28	--	--	--	--	1
541	BTS 8555		--	--	4.09	2.58	--	--	4.09	3.36	3.72	--	--	--	--	1
550	BTS 8580		--	--	3.46	2.42	--	--	3.46	3.15	3.31	--	--	--	--	1
509	BTS 8598		--	--	3.05	2.78	--	--	3.05	3.62	3.34	--	--	--	--	1
512	BTS 8927		--	--	3.35	3.06	--	--	3.35	3.99	3.67	4.04	3.78	4.41	3.26	7
537	Crystal 022		--	--	3.16	2.69	--	--	3.16	3.51	3.33	3.64	3.65	3.95	3.66	6
525	Crystal 130		--	--	2.95	3.05	--	--	2.95	3.98	3.46	3.59	3.73	3.72	4.00	5
545	Crystal 138		--	--	3.50	2.78	--	--	3.50	3.62	3.56	3.70	3.82	3.84	4.06	5
517	Crystal 260		--	--	3.19	3.05	--	--	3.19	3.98	3.58	3.83	3.83	4.08	3.84	4
503	Crystal 269		--	--	2.67	2.67	--	--	2.67	3.48	3.07	3.29	3.40	3.50	3.62	4
546	Crystal 361		--	--	3.05	2.47	--	--	3.05	3.22	3.13	3.47	3.46	3.80	3.45	3
539	Crystal 364		--	--	3.52	2.49	--	--	3.52	3.25	3.38	3.58	3.65	3.78	3.79	3
542	Crystal 369		--	--	2.86	2.95	--	--	2.86	3.84	3.35	3.40	3.61	3.45	4.02	3
522	Crystal 470		--	--	3.75	2.87	--	--	3.75	3.74	3.74	3.71	--	3.67	--	2
548	Crystal 471		--	--	3.46	2.91	--	--	3.46	3.79	3.62	3.81	--	3.99	--	2
531	Crystal 580		--	--	3.73	2.82	--	--	3.73	3.68	3.70	--	--	--	--	1
501	Crystal 581		--	--	3.20	2.46	--	--	3.20	3.21	3.20	--	--	--	--	1
544	Crystal 583		--	--	3.81	2.52	--	--	3.81	3.28	3.55	--	--	--	--	1
507	Crystal 584		--	--	3.43	2.51	--	--	3.43	3.27	3.35	--	--	--	--	1
528	Crystal 591		--	--	3.50	2.57	--	--	3.50	3.35	3.42	--	--	--	--	1
513	Crystal 594		--	--	3.85	3.24	--	--	3.85	4.22	4.03	--	--	--	--	1
516	Crystal 793		--	--	2.83	2.70	--	--	2.83	3.52	3.17	3.45	3.73	3.72	4.31	9
536	Crystal 912		--	--	3.21	2.55	--	--	3.21	3.32	3.27	3.42	3.42	3.57	3.41	7
532	Hilleshög HIL2389		--	--	3.65	3.03	--	--	3.65	3.95	3.80	3.68	4.26	3.56	5.42	5
538	Hilleshög HIL2479		--	--	4.64	2.85	--	--	4.64	3.71	4.18	4.47	4.44	4.76	4.38	3
524	Hilleshög HIL2480		--	--	4.49	2.79	--	--	4.49	3.64	4.06	4.25	4.26	4.43	4.30	3
553	Hilleshög HIL2493		--	--	4.59	3.03	--	--	4.59	3.95	4.27	4.21	--	4.15	--	2
510	Hilleshög HIL2494		--	--	4.51	2.88	--	--	4.51	3.75	4.13	4.11	--	4.10	--	2
515	Hilleshög HIL2532		--	--	3.80	2.83	--	--	3.80	3.69	3.74	--	--	--	--	1
523	Hilleshög HIL2533		--	--	5.19	3.23	--	--	5.19	4.21	4.70	--	--	--	--	1
521	Hilleshög HIL2534		--	--	4.21	2.54	--	--	4.21	3.31	3.76	--	--	--	--	1
552	Hilleshög HIL2535		--	--	4.21	3.82	--	--	4.21	4.98	4.59	--	--	--	--	1
527	Maribo MA717		--	--	5.05	3.61	--	--	5.05	4.71	4.88	4.53	4.55	4.18	4.61	9
533	SX 1815		--	--	3.73	3.71	--	--	3.73	4.84	4.28	4.12	4.80	3.96	6.15	5
530	SX 1835		--	--	4.09	3.67	--	--	4.09	4.78	4.43	4.37	4.91	4.31	5.99	3
526	SV 231		--	--	4.43	2.91	--	--	4.43	3.79	4.11	4.27	4.93	4.43	6.25	3
520	SV 251		--	--	4.30	3.33	--	--	4.30	4.34	4.32	--	--	--	--	1
514	SV 254		--	--	4.65	3.09	--	--	4.65	4.03	4.34	--	--	--	--	1
551	SV 255		--	--	4.32	3.65	--	--	4.32	4.76	4.54	--	--	--	--	1
508	SV 256		--	--	4.22	3.63	--	--	4.22	4.73	4.47	--	--	--	--	1
535	SV 345		--	--	4.56	2.82	--	--	4.56	3.68	4.12	4.16	--	4.20	--	2
519	SV 347		--	--	4.05	3.23	--	--	4.05	4.21	4.13	4.18	--	4.22	--	2
1	1001 AP CK#32	CRYS981	--	--	2.57	3.38	--	--	2.57	4.41	3.49	3.66	3.81	3.84	4.10	17
1	1002 AP CK#43	BTS80RR32	--	--	4.87	3.22	--	--	4.87	4.20	4.53	4.75	4.89	4.97	5.17	16
1	1003 AP CK#45	CRYS986	--	--	4.60	3.72	--	--	4.60	4.85	4.72	4.41	4.28	4.09	4.01	17
1	1004 AP CK#51	CRYS246	--	--	4.80	4.38	--	--	4.80	5.71	5.25	5.04	4.88	4.82	4.58	14
1	1005 AP CK#55	CRYS247	--	--	4.53	3.27	--	--	4.53	4.26	4.39	4.66	4.59	4.93	4.46	14
1	1006 AP CK#56	BTS8363	--	--	6.90	5.70	--	--	6.89	7.43	7.16	6.43	5.96	5.69	5.03	13
1	1007 AP CK#57	CRYS578	--	--	3.94	2.81	--	--	3.94	3.66	3.80	4.12	4.19	4.45	4.33	11
1	1008 AP CK#58	CRYS572	--	--	4.48	3.12	--	--	4.48	4.07	4.27	4.31	4.42	4.36	4.63	11
1	1009 AP CK#59	BTS8606	--	--	4.19	3.49	--	--	4.19	4.55	4.37	4.48	4.46	4.59	4.43	10
1	1010 AP CK#61	HIL9708	--	--	4.79	2.58	--	--	4.79	3.36	4.07	4.40	4.58	4.73	4.93	11
1	1011 AP CK#63	HIL9920	--	--	4.10	3.60	--	--	4.10	4.69	4.39	4.25	4.66	4.11	5.49	9
1	1012 AP CK#64	SX1818	--	--	5.89	3.40	--	--	5.89	4.43	5.16	4.85	5.60	4.54	7.09	5
12		Check Mean	--	--	4.64	3.56	--	--	4.63	4.63	4.63					
		Trial Mean	--	--	3.87	3.08	--	--	3.87	4.01	3.94					
		Coeff. of Var. (%)	--	--	10.1	17.2										
		Mean LSD (0.05)	--	--	0.47	0.78										
		Mean LSD (0.01)	--	--	0.62	1.03										
		Sig Lvl	--	--	**	**										
		Adjustment Factor					NA	NA	0.999	1.303						

++ Ratings adjusted to 2003 basis. (2000-2002 Aph nurseries). Ratings adjusted on the basis of checks.
$$ Trial years indicates how many years the entry has been in the official trials.
[Z] Trial mean and statistics for Shakopee include five extra filler entries (not shown)
Chk = varieties used to adjust Aph readings to 2003 basis. Ratings * (Adj. factor) = Adj Rating.

Perley (Perl) and Alvarado (Alva) not rated due to lack of Aphanomyces pressure
Lower numbers indicate better Aphanomyces resistance (1=Ex, 9=Poor)
Ratings in green font indicate good resistance.
Ratings in red font indicate a level of concern.

Table 27. 2025 Cercospora Ratings for Official Trial Entries

KWS (Randolph, MN) - BSDF (Saginaw, MI) - AC South (Averill, MN) - AC Middle (Caledonia, ND) - AC North (Stephen, MN)

		Unadjusted					Adjusted ++										
Chk	Code Description	KWS[z] Avg 10 Dates+	BSDF Avg 4 Dates+	Averill Avg 6 Dates+	Caledonia Avg 6 Dates+	Stephen Avg 6 Dates+	KWS[z] Avg 10 Dates+	BSDF Avg 4 Dates+	Averill Avg 6 Dates+	Caledonia Avg 6 Dates+	Stephen Avg 6 Dates+	2025 5 loc	2 Yr	3 Yr	2024++	2023++	Trial Yrs $$
	534 BTS 8018	2.20	4.14	4.43	3.34	3.13	2.03	4.32	4.53	4.33	4.17	3.88	3.62	3.22	3.35	2.42	6
	506 BTS 8034	2.97	4.77	4.40	3.96	3.04	2.74	4.98	4.50	5.14	4.05	4.28	3.99	3.51	3.69	2.54	6
	529 BTS 8156	3.05	4.97	4.66	3.95	2.99	2.81	5.18	4.77	5.13	3.99	4.38	4.12	3.59	3.87	2.53	5
	504 BTS 8226	2.52	4.20	4.57	3.63	3.12	2.33	4.38	4.68	4.71	4.16	4.05	3.79	3.30	3.52	2.33	4
	549 BTS 8270	2.21	3.72	4.18	3.14	2.65	2.04	3.88	4.28	4.07	3.53	3.56	3.44	3.10	3.32	2.43	4
	505 BTS 8365	4.55	3.76	3.72	2.99	2.97	4.20	3.92	3.81	3.88	3.96	3.95	4.07	4.10	4.18	4.15	3
	511 BTS 8440	1.91	3.68	3.77	2.78	2.14	1.76	3.84	3.86	3.61	2.85	3.18	3.04	--	2.90	--	2
	518 BTS 8457	2.46	4.57	4.33	3.61	3.14	2.27	4.77	4.43	4.68	4.19	4.07	3.81	--	3.55	--	2
	540 BTS 8509	4.21	3.98	3.57	2.77	2.53	3.88	4.15	3.65	3.59	3.37	3.73	--	--	--	--	1
	547 BTS 8513	2.54	3.84	4.02	3.23	2.62	2.34	4.01	4.11	4.19	3.49	3.63	--	--	--	--	1
	502 BTS 8520	2.24	3.99	4.15	3.23	2.93	2.07	4.16	4.25	4.19	3.91	3.71	--	--	--	--	1
	543 BTS 8531	4.29	4.30	3.83	3.22	3.05	3.96	4.49	3.92	4.18	4.07	4.12	--	--	--	--	1
	541 BTS 8555	3.69	4.16	3.69	2.99	3.01	3.40	4.34	3.78	3.88	4.01	3.88	--	--	--	--	1
	550 BTS 8580	1.69	3.70	3.23	2.58	2.19	1.56	3.86	3.31	3.35	2.92	3.00	--	--	--	--	1
	509 BTS 8598	1.86	4.03	3.90	3.14	2.78	1.72	4.20	3.99	4.07	3.71	3.54	--	--	--	--	1
	512 BTS 8927	4.61	4.03	3.95	3.17	3.35	4.25	4.20	4.04	4.11	4.47	4.22	4.34	4.35	4.45	4.38	7
	537 Crystal 022	4.69	4.55	4.68	3.77	3.86	4.33	4.75	4.79	4.89	5.15	4.78	4.72	4.81	4.66	4.97	6
	525 Crystal 130	2.62	4.55	4.75	3.78	3.30	2.42	4.75	4.86	4.91	4.40	4.27	3.92	3.48	3.56	2.60	5
	545 Crystal 138	4.53	4.47	4.21	3.53	3.47	4.18	4.66	4.31	4.58	4.63	4.47	4.60	4.66	4.73	4.77	5
	517 Crystal 260	2.07	4.22	4.01	3.25	2.54	1.91	4.40	4.10	4.22	3.39	3.60	3.37	2.96	3.13	2.15	4
	503 Crystal 269	4.99	4.20	4.36	3.34	3.22	4.60	4.38	4.46	4.33	4.29	4.42	4.48	4.45	4.54	4.38	4
	546 Crystal 361	2.37	3.91	4.05	3.36	2.83	2.19	4.08	4.14	4.36	3.77	3.71	3.52	3.09	3.33	2.24	3
	539 Crystal 364	4.93	3.69	4.21	3.64	3.30	4.55	3.85	4.31	4.72	4.40	4.37	4.41	4.36	4.46	4.26	3
	542 Crystal 369	4.20	3.63	3.96	2.98	2.88	3.88	3.79	4.05	3.87	3.84	3.88	3.96	3.90	4.03	3.78	3
	522 Crystal 470	2.63	4.42	4.75	3.71	3.25	2.43	4.61	4.86	4.81	4.33	4.21	3.96	--	3.71	--	2
	548 Crystal 471	2.56	4.31	4.75	3.73	2.96	2.36	4.50	4.86	4.84	3.95	4.10	3.79	--	3.49	--	2
	531 Crystal 580	2.40	4.32	4.91	3.36	3.20	2.21	4.51	5.02	4.36	4.27	4.07	--	--	--	--	1
	501 Crystal 581	2.33	4.01	4.39	3.31	3.12	2.15	4.18	4.49	4.30	4.16	3.86	--	--	--	--	1
	544 Crystal 583	4.68	4.26	4.23	3.54	3.14	4.32	4.44	4.33	4.59	4.19	4.37	--	--	--	--	1
	507 Crystal 584	4.32	3.77	3.65	3.03	2.76	3.99	3.93	3.73	3.93	3.68	3.85	--	--	--	--	1
	528 Crystal 591	1.89	3.47	3.67	2.89	2.48	1.74	3.62	3.76	3.75	3.31	3.24	--	--	--	--	1
	513 Crystal 594	5.09	4.36	4.77	3.75	3.58	4.70	4.55	4.88	4.87	4.77	4.75	--	--	--	--	1
	516 Crystal 793	4.45	3.55	4.02	3.11	2.97	4.11	3.70	4.11	4.04	3.96	3.98	4.13	4.15	4.28	4.20	9
	536 Crystal 912	5.08	4.96	4.82	3.91	4.00	4.69	5.17	4.93	5.07	5.33	5.04	5.05	5.03	5.06	5.00	7
	532 Hilleshög HIL2389	5.27	3.82	4.63	3.55	3.36	4.86	3.99	4.74	4.61	4.48	4.53	4.55	4.54	4.57	4.51	5
	538 Hilleshög HIL2479	4.29	4.53	4.29	3.21	2.86	3.96	4.73	4.39	4.17	3.81	4.21	4.23	4.18	4.25	4.09	3
	524 Hilleshög HIL2480	4.66	4.53	4.04	3.30	2.80	4.30	4.73	4.13	4.28	3.73	4.24	4.16	4.11	4.08	4.00	3
	553 Hilleshög HIL2493	5.20	4.31	4.65	3.64	3.35	4.80	4.50	4.76	4.72	4.47	4.65	4.74	--	4.82	--	2
	510 Hilleshög HIL2494	4.80	4.14	4.97	3.63	3.71	4.43	4.32	5.09	4.71	4.95	4.70	4.65	--	4.60	--	2
	515 Hilleshög HIL2532	5.33	4.12	4.64	3.71	3.43	4.92	4.30	4.75	4.81	4.57	4.67	--	--	--	--	1
	523 Hilleshög HIL2533	5.17	4.22	4.78	3.82	3.72	4.77	4.40	4.89	4.96	4.96	4.80	--	--	--	--	1
	521 Hilleshög HIL2534	4.91	3.90	4.62	3.58	3.60	4.53	4.07	4.73	4.65	4.80	4.55	--	--	--	--	1
	552 Hilleshög HIL2535	5.44	4.48	4.70	3.83	3.54	5.02	4.67	4.81	4.97	4.72	4.84	--	--	--	--	1
	527 Maribo MA717	5.40	4.53	4.81	3.81	3.38	4.98	4.73	4.92	4.94	4.51	4.82	4.83	4.90	4.85	5.04	9
	533 SX 1815	5.09	4.64	4.67	3.78	3.35	4.70	4.84	4.78	4.91	4.47	4.74	4.72	4.73	4.70	4.74	5
	530 SX 1835	5.06	4.00	4.64	3.58	3.57	4.67	4.17	4.75	4.65	4.76	4.60	4.63	4.60	4.66	4.55	3
	526 SV 231	5.26	4.14	4.82	3.77	3.50	4.85	4.32	4.93	4.89	4.67	4.73	4.75	4.78	4.77	4.83	3
	520 SV 251	4.74	4.42	4.37	3.69	3.72	4.37	4.61	4.47	4.79	4.96	4.64	--	--	--	--	1
	514 SV 254	4.64	4.03	4.21	3.50	3.03	4.28	4.20	4.31	4.54	4.04	4.28	--	--	--	--	1
	551 SV 255	4.93	4.30	4.71	3.60	3.21	4.55	4.49	4.82	4.67	4.28	4.56	--	--	--	--	1
	508 SV 256	5.03	4.23	4.52	3.52	3.49	4.64	4.41	4.63	4.57	4.65	4.58	--	--	--	--	1
	535 SV 345	5.16	4.71	4.82	3.79	3.52	4.76	4.91	4.93	4.92	4.69	4.84	4.89	--	4.93	--	2
	519 SV 347	5.23	4.56	4.55	3.75	3.39	4.83	4.76	4.66	4.87	4.52	4.73	4.77	--	4.81	--	2
1	1101 CR CK#41 CRYS981RR	5.73	5.40	5.51	3.83	4.13	5.29	5.63	5.64	4.97	5.51	5.41	5.32	5.22	5.23	5.04	17
1	1102 CR CK#43 CRYS246RR	5.29	4.49	4.46	3.69	3.67	4.88	4.68	4.56	4.79	4.89	4.76	4.73	4.69	4.70	4.62	14
1	1103 CR CK#44 BETA80RR32	5.68	4.77	4.53	3.88	3.41	5.24	4.98	4.64	5.03	4.55	4.89	4.96	5.01	5.03	5.10	16
1	1104 CR CK#45 HIL4448RR	5.63	5.07	5.41	4.22	4.22	5.20	5.29	5.54	5.48	5.63	5.42	5.50	5.53	5.57	5.58	14
1	1105 CR CK#48 MARI504	5.30	5.32	5.11	3.82	4.05	4.89	5.55	5.23	4.96	5.40	5.21	5.17	5.07	5.14	4.87	11
1	1106 CR CK#49 CRYS578RR	5.24	4.22	4.81	3.40	3.61	4.84	4.40	4.92	4.41	4.81	4.68	4.76	4.76	4.84	4.77	11
1	1107 CR CK#51 CRYS355RR	4.94	4.70	4.77	3.44	3.52	4.56	4.90	4.88	4.46	4.69	4.70	4.78	4.78	4.86	4.77	13
1	1108 CR CK#52 MARI717	5.22	5.14	4.46	4.02	3.51	4.82	5.36	4.56	5.22	4.68	4.93	4.88	4.82	4.84	4.70	9
1	1109 CR CK#53 CRYS684RR	4.79	3.74	3.91	3.40	3.14	4.42	3.90	4.00	4.41	4.19	4.18	4.28	4.30	4.37	4.34	10
1	1110 CR CK#54 CRYS912	5.07	4.79	4.97	3.82	3.68	4.68	5.00	5.09	4.96	4.91	4.93	4.85	4.90	4.77	5.00	7
1	1111 CR CK#55 HIL2366	5.38	4.67	4.91	4.03	3.73	4.96	4.87	5.02	5.23	4.97	5.01	4.97	4.99	4.93	5.02	6
1	1112 CR CK#56 SES203	5.56	4.15	4.71	3.84	3.50	5.13	4.33	4.82	4.98	4.67	4.79	4.69	4.72	4.60	4.78	6
12	Check Mean	5.32	4.71	4.80	3.78	3.68	4.91	4.91	4.91	4.91	4.91	4.91					
	Trial Mean	4.16	4.29	4.43	3.51	3.25	3.84	4.48	4.53	4.55	4.33	4.35					
	Coeff. of Var. (%)	4.9	7.90	7.5	6.5	11.3											
	Mean LSD (0.05)	0.27	0.52	0.39	0.27	0.43											
	Mean LSD (0.01)	0.35	0.69	0.52	0.35	0.56											
	Sig Mrk	**	**	**	**	**											
	Adj Factor						0.92275	1.04321	1.02327	1.29763	1.33347						

++ Ratings adjusted to 1982 basis (1978-81 CR nurseries). Ratings adjusted on the basis of checks.

$$ Trial years indicates how many years the entry has been in the official trials.

[z] Trial mean and statistics for Randolph include four extra filler varieties (not shown)

Chk = varieties used to adjust CR readings to 1982 basis. Ratings * (Adj. factor) = Adj Rating.

+ Average rating based upon multiple rating dates.

Lower numbers indicate better Cercospora resistance (1-Ex,9=Poor).

Ratings in green font indicate good resistance.

Ratings in red font indicate a level of concern.

Table 28. 2025 Fusarium Ratings for Official Trial Entries
ACSC (Moorhead, MN) - ACSC (Sabin, MN)

		Unadjusted		Adjusted ++							
Chk	Code Description	Mhd[z] 4 Dates+	Sab[z] 4 Dates+	Mhd[z] 4 Dates+	Sab[z] 4 Dates+	2025	2 Yr	3 Yr	2024	2023	Trial Yrs $$
	534 BTS 8018	1.81	1.10	2.37	2.48	2.42	2.31	2.61	2.19	3.20	6
	506 BTS 8034	1.52	1.17	1.99	2.64	2.31	2.10	2.31	1.89	2.72	6
	529 BTS 8156	1.67	1.12	2.19	2.53	2.36	2.25	2.44	2.15	2.80	5
	504 BTS 8226	2.08	1.37	2.72	3.09	2.91	2.77	3.13	2.64	3.85	4
	549 BTS 8270	1.55	1.12	2.03	2.53	2.28	2.34	2.71	2.41	3.46	4
	505 BTS 8365	1.81	1.22	2.37	2.75	2.56	2.35	2.71	2.15	3.43	3
	511 BTS 8440	1.80	1.16	2.36	2.62	2.49	2.73	--	2.97	--	2
	518 BTS 8457	1.99	1.23	2.60	2.77	2.69	2.52	--	2.35	--	2
	540 BTS 8509	1.51	1.16	1.98	2.62	2.30	--	--	--	--	1
	547 BTS 8513	1.50	1.08	1.96	2.44	2.20	--	--	--	--	1
	502 BTS 8520	1.49	1.11	1.95	2.50	2.23	--	--	--	--	1
	543 BTS 8531	1.54	1.01	2.01	2.28	2.15	--	--	--	--	1
	541 BTS 8555	1.52	1.07	1.99	2.41	2.20	--	--	--	--	1
	550 BTS 8580	1.90	1.13	2.49	2.55	2.52	--	--	--	--	1
	509 BTS 8598	1.94	1.12	2.54	2.53	2.53	--	--	--	--	1
	512 BTS 8927	1.51	1.06	1.98	2.39	2.18	2.14	2.45	2.10	3.08	7
	537 Crystal 022	1.69	1.09	2.21	2.46	2.33	2.54	2.84	2.75	3.43	6
	525 Crystal 130	1.77	1.26	2.32	2.84	2.58	2.67	2.96	2.76	3.55	5
	545 Crystal 138	2.03	1.13	2.66	2.55	2.60	2.79	3.11	2.98	3.76	5
	517 Crystal 260	2.15	1.09	2.81	2.46	2.64	2.51	2.80	2.38	3.38	4
	503 Crystal 269	1.63	1.08	2.13	2.44	2.28	2.41	2.98	2.54	4.11	4
	546 Crystal 361	1.56	1.14	2.04	2.57	2.31	2.16	2.52	2.02	3.24	3
	539 Crystal 364	1.52	1.10	1.99	2.48	2.23	2.18	2.49	2.12	3.12	3
	542 Crystal 369	1.73	1.02	2.26	2.30	2.28	2.27	2.59	2.25	3.24	3
	522 Crystal 470	2.00	1.26	2.62	2.84	2.73	2.49	--	2.25	--	2
	548 Crystal 471	1.79	1.09	2.34	2.46	2.40	2.25	--	2.10	--	2
	531 Crystal 580	1.03	1.05	1.35	2.37	1.86	--	--	--	--	1
	501 Crystal 581	1.38	1.05	1.81	2.37	2.09	--	--	--	--	1
	544 Crystal 583	1.94	1.17	2.54	2.64	2.59	--	--	--	--	1
	507 Crystal 584	1.18	1.05	1.54	2.37	1.96	--	--	--	--	1
	528 Crystal 591	1.15	0.99	1.50	2.23	1.87	--	--	--	--	1
	513 Crystal 594	1.28	1.24	1.67	2.80	2.24	--	--	--	--	1
	516 Crystal 793	1.69	1.20	2.21	2.71	2.46	2.43	2.76	2.40	3.40	9
	536 Crystal 912	3.18	1.92	4.16	4.33	4.25	3.86	3.84	3.46	3.82	7
	532 Hilleshög HIL2389	4.01	2.50	5.25	5.64	5.44	5.46	5.47	5.49	5.50	5
	538 Hilleshög HIL2479	3.78	1.76	4.95	3.97	4.46	4.53	4.50	4.59	4.43	3
	524 Hilleshög HIL2480	2.08	1.12	2.72	2.53	2.62	2.84	2.99	3.06	3.30	3
	553 Hilleshög HIL2493	2.96	2.17	3.87	4.89	4.38	4.55	--	4.72	--	2
	510 Hilleshög HIL2494	2.77	1.68	3.62	3.79	3.71	3.63	--	3.56	--	2
	515 Hilleshög HIL2532	4.03	2.37	5.27	5.34	5.31	--	--	--	--	1
	523 Hilleshög HIL2533	3.31	1.97	4.33	4.44	4.39	--	--	--	--	1
	521 Hilleshög HIL2534	2.90	1.75	3.79	3.95	3.87	--	--	--	--	1
	552 Hilleshög HIL2535	4.14	2.96	5.42	6.67	6.05	--	--	--	--	1
	527 Maribo MA717	3.87	2.24	5.06	5.05	5.06	4.71	4.65	4.36	4.53	9
	533 SX 1815	4.51	2.75	5.90	6.20	6.05	5.80	5.73	5.54	5.60	5
	530 SX 1835	3.55	2.10	4.64	4.74	4.69	4.10	4.04	3.52	3.92	3
	526 SV 231	3.62	2.39	4.74	5.39	5.06	4.84	4.63	4.62	4.21	3
	520 SV 251	3.87	2.28	5.06	5.14	5.10	--	--	--	--	1
	514 SV 254	3.73	2.20	4.88	4.96	4.92	--	--	--	--	1
	551 SV 255	3.41	2.25	4.46	5.07	4.77	--	--	--	--	1
	508 SV 256	3.46	2.29	4.53	5.16	4.85	--	--	--	--	1
	535 SV 345	3.68	2.25	4.81	5.07	4.94	4.65	--	4.35	--	2
	519 SV 347	3.55	2.36	4.64	5.32	4.98	4.74	--	4.50	--	2
1	1201 FS CK #18 CRYS768RR	3.09	1.63	4.04	3.68	3.86	4.10	4.13	4.33	4.19	17
1	1202 FS CK #29 CRYS875RR	3.47	2.07	4.54	4.67	4.60	4.51	4.60	4.43	4.76	18
1	1203 FS CK #30 BTS8337	2.93	1.44	3.83	3.25	3.54	3.41	3.51	3.28	3.71	13
1	1204 FS CK #31 SXMarathon	4.28	1.95	5.60	4.40	5.00	4.92	4.99	4.85	5.13	11
1	1205 FS CK #32 CRYS574	1.38	1.12	1.81	2.53	2.17	2.29	2.51	2.41	2.96	11
1	1206 FS CK #33 SES375	4.11	2.77	5.38	6.25	5.81	5.38	5.34	4.95	5.25	9
1	1207 FS CK #34 SES265	4.39	2.10	5.74	4.74	5.24	5.38	5.46	5.53	5.62	10
1	1208 FS CK #35 SES203	4.81	3.25	6.29	7.33	6.81	6.66	6.30	6.50	5.59	6
1	1209 FS CK #36 SES285	4.37	2.82	5.72	6.36	6.04	6.33	6.06	6.63	5.51	8
1	1210 FS Ck#37 HIL2317	4.43	2.47	5.80	5.57	5.68	5.77	5.79	5.86	5.83	7
10	Check Mean	3.73	2.16	4.88	4.88	4.88					
	Trial Mean	2.56	1.61	3.35	3.63	3.49					
	Coeff. of Var. (%)	17.3	15.7								
	Mean LSD (0.05)	0.55	0.30								
	Mean LSD (0.01)	0.72	0.39								
	Sig Mrk	**	**								
	Adj Factor			1.3084	2.2549						

++ Ratings adjusted to 2007 basis. (2005-2006 Fus Nurseries). Ratings adjusted on the basis of checks.
$$ Trial years indicates how many years the entry has been in the official trials.
[z] Trial mean and statistics for Moorhead and Sabin include one extra filler variety (not shown)
Chk = varieties used to adjust Fus readings to 2007 basis. Ratings * (Adj. factor) = Adj Rating.
+ Average rating based upon multiple rating dates.

Lower numbers indicate better Fusarium resistance (1=Ex, 9=Poor).
Ratings in green font indicate good resistance.
Ratings in red font indicate a level of concern.

Table 29. 2025 Rhizoctonia Ratings for Official Trial Entries
BSDF (Saginaw, MI) - ACSC (TSC S) - ACSC (TSC N) - ACSC (NWROC)

		Unadjusted				Adjusted ++									
Chk	Code Description	BSDF 8/8	TSC-S[z] 7/31	TSC-N[z] 8/19	NWROC[z] 8/13	BSDF 8/8	TSC-S[z] 7/31	TSC-N[z] 8/19	NWROC[z] 8/13	2025	2 Yr	3 Yr	2024++	2023++	Trial Yrs $$
	534 BTS 8018	4.89	3.70	4.13	3.30	3.84	3.81	4.05	3.61	3.83	3.75	3.86	3.68	4.06	6
	506 BTS 8034	5.27	4.09	4.54	3.63	4.14	4.22	4.46	3.97	4.20	4.29	4.22	4.38	4.09	6
	529 BTS 8156	5.84	4.11	4.50	3.92	4.59	4.24	4.42	4.28	4.38	4.33	4.20	4.28	3.93	5
	504 BTS 8226	5.03	3.48	3.66	3.13	3.95	3.59	3.59	3.42	3.64	3.55	3.62	3.46	3.78	4
	549 BTS 8270	4.90	3.76	4.20	3.26	3.85	3.88	4.12	3.56	3.85	3.85	3.79	3.86	3.67	4
	505 BTS 8365	4.84	3.79	3.54	3.41	3.81	3.91	3.48	3.73	3.73	3.67	3.67	3.60	3.69	3
	511 BTS 8440	5.31	3.84	3.57	3.35	4.17	3.96	3.50	3.66	3.82	3.75	--	3.68	--	2
	518 BTS 8457	5.11	3.74	3.68	3.27	4.02	3.85	3.61	3.57	3.76	3.74	--	3.71	--	2
	540 BTS 8509	5.50	3.63	3.79	3.28	4.32	3.74	3.72	3.58	3.84	--	--	--	--	1
	547 BTS 8513	4.98	3.24	3.42	2.82	3.92	3.34	3.36	3.08	3.42	--	--	--	--	1
	502 BTS 8520	5.39	3.69	3.76	3.61	4.24	3.80	3.69	3.94	3.92	--	--	--	--	1
	543 BTS 8531	5.01	4.19	4.79	3.86	3.94	4.32	4.70	4.22	4.29	--	--	--	--	1
	541 BTS 8555	5.42	3.73	4.16	3.70	4.26	3.84	4.08	4.04	4.06	--	--	--	--	1
	550 BTS 8580	5.73	4.06	4.11	3.65	4.50	4.18	4.03	3.99	4.18	--	--	--	--	1
	509 BTS 8598	5.20	3.77	3.81	3.38	4.09	3.89	3.74	3.69	3.85	--	--	--	--	1
	512 BTS 8927	4.86	3.79	3.85	3.62	3.82	3.91	3.78	3.95	3.87	3.72	3.81	3.57	3.98	7
	537 Crystal 022	5.00	3.83	3.83	3.50	3.93	3.95	3.76	3.82	3.87	3.75	3.78	3.63	3.85	6
	525 Crystal 130	4.70	3.76	4.01	3.36	3.69	3.88	3.94	3.67	3.79	3.67	3.67	3.54	3.69	5
	545 Crystal 138	5.07	3.65	3.70	3.40	3.99	3.76	3.63	3.71	3.77	3.73	3.76	3.68	3.81	5
	517 Crystal 260	5.31	3.72	3.80	3.18	4.17	3.83	3.73	3.47	3.80	3.75	3.65	3.70	3.46	4
	503 Crystal 269	5.28	3.80	4.46	3.49	4.15	3.92	4.38	3.81	4.06	4.18	4.09	4.30	3.90	4
	546 Crystal 361	5.32	3.81	4.08	3.52	4.18	3.93	4.01	3.85	3.99	3.88	3.77	3.78	3.54	3
	539 Crystal 364	4.83	3.52	3.64	3.10	3.80	3.63	3.57	3.39	3.60	3.69	3.72	3.77	3.79	3
	542 Crystal 369	5.32	4.23	4.36	3.90	4.18	4.36	4.28	4.26	4.27	4.49	4.32	4.72	3.98	3
	522 Crystal 470	4.98	3.75	3.74	3.36	3.92	3.87	3.67	3.67	3.78	3.82	--	3.85	--	2
	548 Crystal 471	4.98	3.62	4.25	3.30	3.92	3.73	4.17	3.61	3.86	3.77	--	3.69	--	2
	531 Crystal 580	5.43	3.56	3.62	3.29	4.27	3.67	3.55	3.59	3.77	--	--	--	--	1
	501 Crystal 581	5.18	3.87	4.16	3.13	4.07	3.99	4.08	3.42	3.89	--	--	--	--	1
	544 Crystal 583	5.53	3.91	3.65	3.29	4.35	4.03	3.58	3.59	3.89	--	--	--	--	1
	507 Crystal 584	4.97	3.85	3.80	3.48	3.91	3.97	3.73	3.80	3.85	--	--	--	--	1
	528 Crystal 591	5.15	3.62	4.18	3.57	4.05	3.73	4.10	3.90	3.95	--	--	--	--	1
	513 Crystal 594	4.80	3.52	3.56	2.96	3.77	3.63	3.49	3.23	3.53	--	--	--	--	1
	516 Crystal 793	5.25	3.99	4.31	3.90	4.13	4.11	4.23	4.26	4.18	4.04	4.14	3.89	4.35	9
	536 Crystal 912	4.08	2.87	3.26	2.86	3.21	2.96	3.20	3.12	3.12	3.29	3.36	3.45	3.50	7
	532 Hilleshög HIL2389	4.87	4.06	4.20	3.56	3.83	4.18	4.12	3.89	4.01	4.04	4.18	4.08	4.45	5
	538 Hilleshög HIL2479	4.81	3.22	3.43	3.23	3.78	3.32	3.37	3.53	3.50	3.87	3.72	4.24	3.43	3
	524 Hilleshög HIL2480	3.94	3.21	3.55	3.28	3.10	3.31	3.49	3.58	3.37	3.51	3.57	3.65	3.70	3
	553 Hilleshög HIL2493	4.67	3.38	3.64	3.22	3.67	3.48	3.57	3.52	3.56	3.69	--	3.83	--	2
	510 Hilleshög HIL2494	4.85	3.89	4.02	3.60	3.81	4.01	3.95	3.93	3.93	3.95	--	3.97	--	2
	515 Hilleshög HIL2532	4.43	3.33	3.83	3.44	3.48	3.43	3.76	3.76	3.61	--	--	--	--	1
	523 Hilleshög HIL2533	4.83	3.55	4.01	3.43	3.80	3.66	3.94	3.75	3.79	--	--	--	--	1
	521 Hilleshög HIL2534	4.96	3.80	4.05	3.80	3.90	3.92	3.98	4.15	3.99	--	--	--	--	1
	552 Hilleshög HIL2535	5.31	4.01	4.49	3.70	4.17	4.13	4.41	4.04	4.19	--	--	--	--	1
	527 Maribo MA717	4.78	3.58	4.16	3.71	3.76	3.69	4.08	4.05	3.90	4.05	4.07	4.19	4.10	9
	533 SX 1815	5.26	3.74	4.61	3.53	4.14	3.85	4.53	3.86	4.09	4.20	4.25	4.30	4.35	5
	530 SX 1835	5.29	3.76	3.66	3.22	4.16	3.88	3.59	3.52	3.79	3.93	3.80	4.07	3.55	3
	526 SV 231	4.79	3.90	3.98	3.26	3.77	4.02	3.91	3.56	3.81	3.76	3.74	3.71	3.69	3
	520 SV 251	5.57	3.94	4.28	3.68	4.38	4.06	4.20	4.02	4.17	--	--	--	--	1
	514 SV 254	4.57	3.84	3.87	3.34	3.59	3.96	3.80	3.65	3.75	--	--	--	--	1
	551 SV 255	4.90	3.77	3.96	3.36	3.85	3.89	3.89	3.67	3.82	--	--	--	--	1
	508 SV 256	4.73	3.96	3.72	3.49	3.72	4.08	3.65	3.81	3.82	--	--	--	--	1
	535 SV 345	5.06	3.58	3.43	3.05	3.98	3.69	3.37	3.33	3.59	3.54	--	3.48	--	2
	519 SV 347	4.88	4.13	3.98	3.73	3.84	4.26	3.91	4.08	4.02	4.15	--	4.28	--	2
1	1301 RH CK#49 CRYS247	5.35	4.39	4.19	3.87	4.21	4.52	4.11	4.23	4.27	4.36	4.34	4.45	4.31	14
1	1302 RH CK#52 CRYS573	5.80	4.16	4.64	4.00	4.56	4.29	4.56	4.37	4.44	4.44	4.37	4.43	4.22	11
1	1303 RH CK#53 BTS8500	5.60	4.21	4.21	3.80	4.40	4.34	4.13	4.15	4.26	4.22	4.23	4.19	4.24	11
1	1304 RH CK#54 CRYS574	5.47	4.02	4.50	3.94	4.30	4.14	4.42	4.30	4.29	4.27	4.32	4.26	4.40	11
1	1305 RH CK#55 CRYS803	5.75	4.45	4.65	4.44	4.52	4.59	4.56	4.85	4.63	4.56	4.53	4.49	4.47	8
1	1306 RH CK#56 MARI504	5.46	3.66	4.30	4.21	4.29	3.77	4.22	4.60	4.22	4.32	4.36	4.43	4.44	11
1	1307 RH CK#57 BTS8606	5.47	4.39	4.74	4.02	4.30	4.52	4.65	4.39	4.47	4.46	4.56	4.46	4.75	10
1	1308 RH CK#58 CRYS793	5.69	4.31	4.38	3.87	4.47	4.44	4.30	4.23	4.36	4.27	4.24	4.18	4.17	9
1	1309 RH Ck#59 SEED1818	4.88	3.79	4.12	3.56	3.84	3.91	4.04	3.89	3.92	4.05	4.05	4.19	4.06	5
1	1310 RH Ck#60 CRYS913	5.67	3.96	4.18	3.79	4.46	4.08	4.10	4.14	4.20	4.08	4.12	3.97	4.19	7
1	1311 RH Ck#61 HIL2386	5.23	3.88	4.10	3.57	4.11	4.00	4.02	3.90	4.01	3.95	3.94	3.90	3.91	5
1	1312 RH Ck#62 HIL9920	5.53	5.02	4.74	4.33	4.35	5.17	4.65	4.73	4.73	4.65	4.57	4.57	4.42	9
12	Mean of Check Varieties	5.49	4.19	4.40	3.95	4.32	4.32	4.32	4.32	4.32					
	Trial Mean	5.12	3.83	4.02	3.52	4.03	3.95	3.95	3.85	3.94					
	Coeff. of Var. (%)	10.5	9.2	8.4	8.8										
	Mean LSD (0.05)	0.69	0.45	0.45	0.37										
	Mean LSD (0.01)	0.92	0.59	0.59	0.49										
	Sig Lvl	**	**	**	**										
	Adjustment Factor					0.7862	1.0307	0.9817	1.0925						

++ Ratings adjusted to 2009 basis (2007-2009) RH nurseries. Ratings adjusted on the basis of checks
$$ Trial years indicates how many years the entry has been in the official trials.
[z] Trial mean and statistics for TSC-S, TSC-N and NWROC include one extra filler entry (not shown)
Chk = varieties used to adjust Rhc readings to 2009 basis. Ratings * (Adj. factor) = Adj Rating.

Lower numbers indicate better Rhizoctonia resistance (0=Ex, 7=Poor).
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	5/14	RU1	6/10	CR1, CR2, CR3, CR4, CR5	7/1, 7/14, GR[A], 8/14, 9/2
Averill	N1	5/14	RU1, RU2	6/11,6/24	CR1, CR2, CR3, CR4, CR5	7/2, 7/14, 7/29, 8/12, 8/25
Perley	None	-	RU1, RU2	6/3,6/24	CR1, CR2, CR3, CR4, CR5	7/2, 7/14, 7/29, 8/12, 8/25
Ada	Grower	4/26	RU1, RU2	5/29,6/27	CR4, CR5	8/18, 8/25
Caledonia	Grower[B]	4/23	RU1	6,24	CR1, CR2, CR3, CR4, CR5	7/8, 7/14, 7/30, 8/12, 8/25
Scandia	N1	5/7	RU1, RU2	6/4,8/11	CR1, CR2, CR3, CR4, CR5	7/2, 7/14, 7/31, 8/12, 8/26
Reynolds	None	-	RU1	6/11	CR1, CR2, CR3, CR4, CR5	7/2, 7/17, 8/1, 8/12, 8/26
EGF	Grower	5/13	RU1	6/3	CR1	7/2
Alvarado	None	-	RU1, RU2	6/4,6/27	CR1, CR2, CR3, CR4, CR5	7/2, 7/17, 7/30, 8/12, 8/26
Stephen	N1	5/7	RU1, RU2	5/29,8/5	CR1, CR2, CR3, CR4, CR5	7/1, 7/17, 7/29, 8/13, 8/27
St. Thomas	None	-	RU1	6/4	CR1, CR2, CR3, CR4, CR5	7/1, 7/17, 7/29, 8/13, 8/27
Northcote	None	-	RU1, RU2	5/29,8/5	CR1, CR2, CR3, CR4, CR5	7/1, 7/17, 7/30, 8/13, 8/27
Bathgate	None	-	RU1, RU2	6/11,8/5	CR1, CR2, CR3, CR4, CR5	7/1, 7/17, 7/30, 8/13, 8/27

Ground applications made by Official Variety Trial personnel from ACSC Tech. Services Center. Created 10/29/2025
Counter 20G (8.9 lbs./A) applied at all locations.
Mustang Maxx (4 fl oz/A) applied post at Ada; Chlorpyrifos 4E AG(2 pt/A) applied post at Reynolds 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)
RU1 and RU2 = Roundup PowerMAX 3 (25 fl oz/A), ClassAct (2.5 gal/100 gal of water).
[A] Grower applied third Cercospora spray by air due to wet soil conditions
[B] Grower applied Dual Magnum (0.5 pt/A) PPI
CR1 = Inspire XT + Manzate Max
CR2 = Agritin + Topsin
CR3 = Manzate Max
CR4 = Manzate Max + Proline (Just manzate at Ada)
CR5 = Priaxor + Agritin