2022
Research Report

Southern Minnesota Beet Sugar Cooperative

SMBSC

Southern Minnesota Agricultural Research

TABLE OF CONTENTS

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SMBSC Research Vision Statement:

Conduct industry leading agronomic and sugar beet storage research that enables Shareholder's data driven decisions to increase productivity and profitability and

SMBSC Research Mission:

- Conduct industry leading research.
- Generate high quality data.
- Work to discover novel agronomic practices to solve the needs of SMBSC shareholders.
- Increase productivity and profitability of SMBSC shareholders.
- Utilize the Shareholder Innovation Committee to bridge small plot research to whole field situations.

SMBSC Sugar Beet Seed Approval & Official Variety Trial Procedures

Cody Groen[1] and **Neil Olson**[2]

[1]Post-Harvest Storage Agronomist, [2]Production Agronomist, SMBSC, Renville, MN

Southern Minnesota Beet Sugar Cooperative (SMBSC) growers face several challenges to producing a high quality, high yielding sugar beet crop. Some of these issues include managing sugar beet diseases such as Aphnomyces root rot, Rhizoctonia root rot, and Cercospora leaf spot. An important tool that SMBSC growers are able to utilize in managing these diseases is varieties' genetic tolerance to those diseases. Genetic tolerance combined with a better understanding of genetic sugar content and yield potential allow for accurate placement of varieties in fields. SMBSC has a Seed Policy that provides guidelines for varieties to be sold to SMBSC growers. This policy creates a competitive system where varieties compete against each other to be permitted for sale, ensuring that the best varieties are selected for growers to place.

Research Objective

- Generate yield and disease tolerance data on candidate varieties entered by seed production companies to move candidate varieties through the SMBSC Seed Approval process, and release varieties for sale to SMBSC growers.

Methodology

The SMBSC Official Variety Trials (OVTs) utilize Yield Trials and Disease Nursery Trials.

Four OVT-Yield Trials locations were planted. These trials were located near Murdock, Wood Lake, Lake Lillian, and Hector. Trials were planted with a modified 12 row John Deere 7300 vacuum planter. Plots were four 22"-rows wide by forty feet long. Each variety was replicated six times across each trial, for a total of 24 plots per variety when combining all locations (four locations * six replications per location). The experimental design of the trials was a partially balanced lattice. Five foot alleys were cut perpendicular to the rows, which is removed from the total 40' plot length so plots lengths were 35' after alleys were cut. Emergence counts were taken approximately 28 days after planting. After the emergence counts were taken, plots were thinned to a uniform spacing of approximately 190 - 200 sugar beets per 100 foot of row, and all doubles were removed. Quadris was banded over the row at approximately the four to six leaf stage to suppress Rhizoctonia root and crown rot.

Weed control was accomplished by applying pre-emergence and post-emergence split lay-by herbicides at the appropriate rates and times. The weeds present at each site dictated the weed control products used at each location. All spraying operations were conducted by a tractor sprayer driving perpendicular to the rows down the tilled alleys. SMBSC Research Staff conducted all the spraying operations. Six Cercospora leaf spot fungicide applications were made at each of the OVT Yield Trial sites.

In late August, row lengths were taken on each harvest row to calculate yield at harvest. All plots were defoliated using a 4-row defoliator. The beets that were within the two feet of row immediately adjacent to the soil alleys were marked using food-grade paint after defoliation. This identified these "end-beets" allowing them to be screened out from the quality samples collected on the harvester, avoiding the potential negative impact on quality the end beets could have given their access to nutrients, and moisture in the alley all growing season. The center two rows of each plot were harvested using a 2-row research harvester. All beets harvested from the center two rows were weighed on a scale on the harvester and a sample of beets was taken for quality analysis at the SMBSC tare lab.

There are three OVT-Disease Nurseries; each replicated at two locations. Cercospora leaf spot (CLS) nurseries were conducted by SMBSC at a location near Renville and at a KWS location near Randolph, MN. Aphanomyces root rot

(APH) nurseries were conducted at KWS's facility in Shakopee, MN, and in the SMBSC Aphanomyces nursery near Renville. Rhizoctonia root rot (RHC) tolerance was tested at a SMBSC location near Renville as well as the BSDF Rhizoctonia nursery in Michigan. For each nursery, all best management practices were followed, except for any disease management for the disease being tested. For instance, the CLS nursery saw the use of Quadris for root rot management, but no CLS fungicides were sprayed on the CLS nursery. Likewise, CLS fungicides were applied to the RHC nursery, but no Quadris was applied. This method is used so that any differences observed can be due to only genetic tolerance to the given disease.

Ratings for CLS nursery occurred approximately two or three-times per week between mid-July and mid-August. Ratings for the APH and RHC nurseries occurred at the beginning of September.

Results and Discussion

Data from all four Yield Trials and all six Disease Nurseries was utilized for CY23 Seed Approval. Data generated in CY22 was combined with the data generated from CY21 and CY20 trials for use in approving varieties for the CY23 crop.

In the following pages, you will find tables that share trial site specifications, data generated in each of the years utilized for approval from the OVT Yield Trial and Disease Nursery process, Agriculturalist Variety Strip Trial results, and the data from each of the prior year's individual Yield Trial locations.

Conclusion

Data generated for the SMBSC Sugar Beet Seed Approval through the Official Variety Trial Procedures can be found in this report as well in other formats on the SMBSC website under the Agronomy section. This robust data set will provide guidance to SMBSC producers to place varieties on their farms to optimize their disease management and production potential.

2022 SMBSC Official Variety Trials

Yield Trials Specifications

Trial Type	Cooperator	Trial Location	Previous Crop	Starter Fertilizer	Planting Date	Thinning Date	Harvest Date	Disease
Yield	G.E. Johnson Inc	Hector	Sweet Corn	No	5/19/2022	6/14/2022	9/27/2022	None to light rot, No CLS
Yield	Steve and Nick Frank	Lake Lillian	Soybean	No	5/16/2022	6/10/2022	9/22/2022	Med to light rot, Light CLS
Yield	Posen Farm Partners	Wood Lake	Field Corn	No	5/24/2022	6/20/2022	10/11/2022	Very dry conditions, No rot, No CLS
Yield	Petersen Farms	Murdock	Field Corn	No	5/23/2022	6/21/2022	10/4/2022	None to light rot, No CLS

Disease Nursery Trials Specifications

Trial Type	Investigator	Trial Location	Rating Performed by	Use of Ratings in 2022 Variety Approval System
Aphanomyces	SMBSC	Renville	SMBSC Staff	50% of 2022 APH Rating
Aphanomyces	KWS	Shakopee	KWS, M. Bloomquist, C. Groen, N. Olson, A. Chanda	50% of 2022 APH Rating
Cercospora	SMBSC	Renville	SMBSC Staff	50% of 2022 CLS Rating
Cercospora	KWS	Randolph	KWS Staff	50% of 2022 CLS Rating
Rhizoctonia	SMBSC	Renville	SMBSC Staff	50% of the 2022 RHC Rating
Rhizoctonia	BSDF - USDA/ARS	Michigan	Linda Hanson and USDA/ARS Staff	50% of the 2022 RHC Rating

Table 1. Comparison of 2023 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Three Years of Data (2020-2022)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Aphanomyces Root Rating**		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Emerge-ence (%)		Revenue per Ton*	Revenue per Acre*	ESTESA ***	
	Specialty	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	3 yr avg	% of mean	% of mean	% of mean	3 yr avg	
2023 Fully Approved Varieties - Three Years of Data (% of Mean is of Fully Approved Mean)																							
Beta 9044		286.6	104.1	10485.1	100.2	17.0	103.5	90.4	100.3	36.9	96.5	4.5	102.0	4.2	116.3	3.9	97.9	73.8	103.1	106.6	103.0	756.0	9044
Beta 9098		273.3	99.2	10630.7	101.5	16.4	99.4	90.0	99.9	39.3	102.7	4.8	109.7	2.3	64.9	4.5	112.5	71.9	100.4	99.2	102.0	737.7	9098
Crystal M002		272.6	99.0	10673.9	102.0	16.3	99.3	90.0	99.8	39.2	102.7	4.4	100.1	1.9	52.7	4.4	108.6	73.4	102.5	98.1	100.7	726.3	M002
Crystal M028		283.3	102.9	10578.8	101.1	16.9	102.5	90.4	100.3	37.5	98.2	4.3	97.0	3.9	108.3	4.1	101.9	74.1	103.5	105.5	103.6	758.8	M028
Hilleshog 2327		270.8	98.3	10405.4	99.4	16.2	98.5	90.0	99.9	38.6	101.0	4.3	96.8	4.1	113.9	3.9	96.4	68.2	95.3	97.0	98.1	706.0	2327
Hilleshog 2379		272.2	98.9	10267.1	98.1	16.3	99.0	90.0	99.9	37.8	99.0	4.3	96.3	4.2	118.0	4.1	101.9	72.2	100.9	98.1	97.1	700.4	2379
SV 881		272.2	98.8	10357.9	98.9	16.3	99.0	90.0	99.9	38.2	99.9	4.4	99.2	4.0	112.6	4.0	100.3	69.2	96.7	98.1	98.1	707.8	881
SV RR863		271.9	98.8	10351.2	98.9	16.2	98.8	90.2	100.1	38.2	99.9	4.4	98.8	4.1	113.2	3.8	93.8	69.8	97.5	97.5	97.5	702.8	863
Mean of Fully Approved:		**275.4**	**100.0**	**10468.8**	**100.0**	**16.5**	**100.0**	**90.1**	**100.0**	**38.2**	**100.0**	**4.4**	**100.0**	**3.6**	**100.0**	**4.0**	**100.0**	**71.6**	**100.0**	**100.0**	**100.0**	**724.5**	**Mean**
2023 Test Market Varieties for Limited Sales - Three Years of Data (% of mean is of Fully Approved Mean)																							
Beta 9088		283.1	102.8	10546.5	100.7	16.9	102.7	90.1	100.0	37.4	97.9	4.5	101.7	4.3	119.9	4.0	100.0	70.0	97.8	104.7	102.6	750.2	9088
2023 Specialty Approved Varieties - Three Years of Data (% of mean is of Fully Approved Mean)																							
Crystal M089	**APH+RHC**	266.1	96.6	10775.8	102.9	16.0	97.3	89.8	99.6	40.8	106.8	4.2	94.1	2.5	68.4	3.7	91.0	75.4	105.4	94.4	101.6	722.6	M089
Crystal M977	**APH+RHC**	270.0	98.1	11098.4	106.0	16.2	98.2	90.0	99.9	41.4	108.4	3.9	88.7	4.5	126.6	3.6	88.5	69.7	97.4	97.0	105.5	757.2	M977
2023 Last Year Sales - Three Years of Data (% of mean is of Fully Approved Mean)																							
Beta 9986		263.6	95.7	10740.2	102.6	15.8	96.0	89.8	99.6	40.9	107.0	4.4	99.4	2.2	61.3	4.1	101.1	73.0	102.0	92.3	98.8	705.3	9986
SV 883		268.5	97.5	10030.5	95.8	16.1	97.9	89.8	99.6	37.5	98.1	4.6	104.0	4.0	111.5	3.8	93.4	73.8	103.1	95.5	93.7	672.9	883
SV RR862		269.3	97.8	10008.5	95.6	16.1	97.9	90.1	100.0	37.3	97.6	4.7	106.2	3.6	100.3	3.8	94.2	71.3	99.6	96.2	93.9	675.3	862

*__Revenue per Ton__ and __Revenue per Acre__ figures were produced using the payment calculation with factors released on Oct. 21, 2022 for the final 2021 crop payment.

** Lower numbers are better for all disease nursery ratings.

***ESTESA is a unitless SMBSC parameter that correlates to grower payment and revenue per acre. Higher is better.

Table 2. Comparison of 2023 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Two Years of Data (2021-2022)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Aphanomyces Root Rating**		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Emerge-ence (%)		Revenue per Ton*	Revenue per Acre*	ESTESA ***	
	Specialty	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	2 yr avg	% of mean	% of mean	% of mean	2 yr avg	
2023 Fully Approved Varieties - Two Years of Data (% of Mean is of Fully Approved Mean)																							
Beta 9044		282.6	104.4	10648.1	100.3	16.8	103.5	90.3	100.4	38.1	96.6	4.7	105.7	4.1	117.6	3.9	95.9	70.9	103.5	107.1	103.5	759.1	9044
Beta 9098		268.1	99.0	10736.2	101.1	16.1	99.2	89.9	100.0	40.4	102.4	4.8	108.0	2.1	60.2	4.6	114.1	69.4	101.3	98.4	100.9	727.1	9098
Crystal M002		268.3	99.1	10849.5	102.2	16.1	99.2	89.8	99.8	40.5	102.7	4.6	103.5	1.8	51.6	4.3	107.0	69.9	102.0	98.1	100.9	726.8	M002
Crystal M028		279.1	103.1	10692.1	100.7	16.7	102.8	90.2	100.3	38.5	97.6	4.4	99.0	3.8	109.0	4.1	101.9	72.8	106.3	105.7	103.3	755.3	M028
Hilleshog 2327		265.1	97.9	10529.0	99.2	16.0	98.5	89.6	99.6	39.9	101.2	4.3	96.7	4.0	114.7	3.8	93.7	64.8	94.6	96.6	97.8	702.4	2327
Hilleshog 2379		268.4	99.1	10395.8	97.9	16.1	99.2	89.9	100.0	38.9	98.6	4.3	96.7	4.1	117.6	4.0	100.6	69.5	101.5	98.4	97.1	700.1	2379
SV 881		267.9	98.9	10605.4	99.9	16.1	99.2	89.8	99.8	39.7	100.7	4.4	99.0	4.0	114.7	3.9	97.0	65.8	96.1	98.1	98.9	712.4	881
SV RR863		266.8	98.5	10487.0	98.8	16.0	98.5	90.0	100.1	39.5	100.2	4.3	96.7	4.0	114.7	3.6	89.7	64.9	94.7	97.5	97.8	703.7	863
Mean of Fully Approved:		**270.8**	**100.0**	**10617.9**	**100.0**	**16.2**	**100.0**	**89.9**	**100.0**	**39.4**	**100.0**	**4.5**	**100.0**	**3.5**	**100.0**	**4.0**	**100.0**	**68.5**	**100.0**	**100.0**	**100.0**	**723.4**	**Mean**
2023 Test Market Varieties for Limited Sales - Two Years of Data (% of mean is of Fully Approved Mean)																							
Beta 9088		276.7	102.2	10713.9	100.9	16.6	102.2	89.9	100.0	38.9	98.6	4.7	105.0	4.3	123.3	4.0	99.0	66.3	96.8	103.9	102.5	746.9	9088
Beta 9124		276.9	102.3	11226.4	105.7	16.5	101.6	90.2	100.3	40.8	103.5	5.0	111.7	2.4	68.8	4.4	110.3	74.7	109.1	103.5	107.2	781.2	9124
Beta 9131		273.9	101.1	11173.9	105.2	16.4	101.0	90.0	100.1	41.1	104.2	4.8	107.3	2.1	60.2	3.5	86.6	68.7	100.3	101.9	106.3	771.2	9131
Beta 9155		263.8	97.4	11103.3	104.6	15.8	97.3	89.9	100.0	42.4	107.5	4.1	91.6	2.6	74.6	3.4	84.9	72.6	106.0	95.1	102.3	735.5	9155
Crystal M106		276.1	102.0	11276.1	106.2	16.5	101.6	90.0	100.1	41.2	104.5	3.9	87.2	4.0	114.7	3.8	95.6	73.1	106.7	103.0	107.7	783.3	M106
Crystal M168		272.0	100.4	10882.6	102.5	16.3	100.4	90.0	100.1	40.2	101.9	4.3	96.1	2.1	60.2	4.3	106.9	70.4	102.8	100.8	102.8	744.9	M168
Hilleshog 2395		263.6	97.3	10335.8	97.3	15.9	97.9	89.7	99.7	39.6	100.4	4.6	102.8	4.3	123.3	4.2	104.9	69.0	100.7	95.7	96.2	690.0	2395
Hilleshog 2398		267.5	98.8	10293.8	96.9	16.1	99.2	89.8	99.8	38.6	97.9	4.6	102.8	3.8	109.0	4.0	99.7	68.6	100.1	98.1	96.1	692.7	2398
Hilleshog 2399		262.2	96.8	10216.6	96.2	15.8	97.3	89.8	99.8	39.1	99.1	5.0	111.7	4.3	123.3	4.0	99.1	62.8	91.7	94.9	94.1	674.3	2399
2023 Specialty Approved Varieties - Two Years of Data (% of mean is of Fully Approved Mean)																							
Crystal M089	APH+RHC	261.0	96.4	11055.2	104.1	15.8	97.3	89.6	99.6	42.6	108.0	4.1	91.6	2.3	65.9	3.5	88.0	73.5	107.3	94.4	102.0	730.3	M089
Crystal M977	APH+RHC	265.8	98.2	11390.3	107.3	16.0	98.5	89.7	99.7	43.2	109.5	3.9	87.2	4.5	129.0	3.4	85.5	65.9	96.2	96.8	106.1	762.8	M977
2023 Last Year Sales - Two Years of Data (% of mean is of Fully Approved Mean)																							
Beta 9986		259.2	95.7	11011.5	103.7	15.6	96.1	89.7	99.7	42.7	108.3	4.5	100.6	2.1	60.2	4.0	98.2	69.0	100.7	92.4	100.1	714.6	9986
SV 883		262.6	97.0	10080.5	94.9	15.9	97.9	89.6	99.6	38.5	97.6	4.8	107.3	3.8	109.0	3.6	89.1	70.2	102.5	95.5	93.3	668.9	883
SV RR862		263.3	97.2	9893.6	93.2	15.8	97.3	89.9	100.0	37.8	95.8	4.7	105.0	3.5	100.4	3.7	91.6	69.8	101.9	95.1	91.2	653.8	862

*__Revenue per Ton__ and **Revenue per Acre** figures were produced using the payment calculation with factors released on Oct. 21, 2022 for the final 2021 crop payment.

** Lower numbers are better for all disease nursery ratings.

***ESTESA is a unitless SMBSC parameter that correlates to grower payment and revenue per acre. Higher is better.

Table 3. Comparison of 2023 Fully Approved Varieties to Test Market and Specialty Approved Varieties - 1 Year Data (2022)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Aphanomyces Root Rating**		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Emerge-ence (%)		Revenue per Ton*	Revenue per Acre*	ESTESA ***	
	Specialty	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	1 yr avg	% of mean	% of mean	% of mean	1 yr avg	
2023 Fully Approved Varieties - One Year of Data (% of Mean is of Fully Approved Mean)																							
Beta 9044		293.9	104.6	9841.2	98.9	17.5	103.6	89.9	100.4	33.8	95.2	4.3	94.8	4.1	119.3	3.8	96.2	65.5	103.2	107.1	102.1	725.5	9044
Beta 9098		276.6	98.4	9796.1	98.4	16.7	98.9	89.4	99.8	36.0	101.4	4.7	103.6	1.9	55.3	4.4	111.5	66.7	105.1	97.6	99.1	689.7	9098
Crystal M002		279.3	99.4	10135.5	101.9	16.8	99.5	89.6	100.0	36.0	101.4	4.3	94.8	1.7	49.5	4.3	108.3	67.2	105.9	99.2	100.6	702.7	M002
Crystal M028		291.8	103.8	10115.5	101.7	17.5	103.6	89.8	100.3	34.6	97.5	4.3	94.8	3.7	107.6	4.1	104.8	67.7	106.7	106.9	104.2	740.5	M028
Hilleshog 2327		276.0	98.2	9884.4	99.3	16.6	98.3	89.5	99.9	35.7	100.6	4.6	101.4	4.1	119.3	3.8	97.1	57.2	90.1	96.9	97.5	677.4	2327
Hilleshog 2379		279.3	99.4	9961.4	100.1	16.8	99.5	89.5	99.9	35.8	100.8	4.3	94.8	4.1	119.3	3.8	96.6	63.1	99.4	98.9	99.8	696.7	2379
SV 881		277.1	98.6	10078.1	101.3	16.7	98.9	89.4	99.8	36.2	102.0	5.0	110.2	3.9	113.5	3.8	96.2	62.0	97.7	97.6	99.7	693.6	881
SV RR863		274.3	97.6	9793.3	98.4	16.5	97.7	89.5	99.9	35.9	101.1	4.8	105.8	4.0	116.4	3.5	89.2	58.2	91.7	95.8	97.0	672.5	863
Mean of Fully Approved:		**281.0**	**100.0**	**9950.7**	**100.0**	**16.9**	**100.0**	**89.6**	**100.0**	**35.5**	**100.0**	**4.5**	**100.0**	**3.4**	**100.0**	**3.9**	**100.0**	**63.5**	**100.0**	**100.0**	**100.0**	**699.8**	**Mean**
2023 Test Market Varieties - One Year of Data (% of mean is of Fully Approved Mean)																							
Beta 9088		288.2	102.5	10026.7	100.8	17.3	102.4	89.6	100.0	34.7	97.7	4.6	101.4	4.4	128.0	4.0	101.1	60.6	95.5	104.3	102.0	720.5	9088
Beta 9124		285.8	101.7	10290.7	103.4	17.2	101.9	89.5	99.9	36.2	102.0	5.0	110.2	2.3	66.9	4.5	114.9	68.7	108.3	103.0	105.1	740.3	9124
Beta 9131		286.5	101.9	10515.6	105.7	17.2	101.9	89.8	100.3	36.9	103.9	4.6	101.4	2.0	58.2	3.5	88.0	60.7	95.7	103.8	107.9	761.4	9131
Beta 9155		271.3	96.5	10421.3	104.7	16.3	96.5	89.6	100.0	38.6	108.7	4.1	90.4	2.4	69.8	3.2	82.2	69.1	108.9	94.0	102.3	706.8	9155
Crystal M106		286.7	102.0	10530.1	105.8	17.1	101.3	89.9	100.4	37.1	104.5	3.6	79.3	4.1	119.3	3.7	94.1	69.4	109.4	103.0	107.7	758.4	M106
Crystal M168		280.0	99.6	10007.5	100.6	16.9	100.1	89.4	99.8	35.9	101.1	4.0	88.2	2.0	58.2	4.3	109.4	68.8	108.4	99.7	100.9	705.3	M168
Hilleshog 2395		275.3	98.0	9537.8	95.9	16.6	98.3	89.4	99.8	34.9	98.3	5.0	110.2	4.4	128.0	4.0	101.9	65.4	103.1	96.6	95.1	660.2	2395
Hilleshog 2398		275.6	98.1	9718.3	97.7	16.7	98.9	89.3	99.7	35.2	99.2	4.5	99.2	3.8	110.5	4.1	103.9	64.6	101.8	97.4	96.7	672.4	2398
Hilleshog 2399		269.2	95.8	9159.0	92.0	16.3	96.5	89.4	99.8	34.1	96.1	5.1	112.4	4.4	128.0	4.0	101.2	51.1	80.5	93.5	89.9	620.7	2399
2023 Specialty Approved Varieties - One Year of Data (% of mean is of Fully Approved Mean)																							
Crystal M089	APH+RHC	270.5	96.3	10613.1	106.7	16.4	97.1	89.3	99.7	39.5	111.3	3.9	86.0	2.2	64.0	3.5	89.9	70.2	110.6	94.3	105.0	726.2	M089
Crystal M977	APH+RHC	279.8	99.6	10837.4	108.9	16.8	99.5	89.9	100.4	38.9	109.6	3.5	77.1	4.7	136.7	3.3	83.5	61.9	97.6	99.9	109.5	766.1	M977
2023 Last Year Sales - One Year of Data (% of mean is of Fully Approved Mean)																							
Beta 9986		271.1	96.5	10533.9	105.9	16.3	96.5	89.6	100.0	38.7	109.0	4.4	97.0	2.0	58.2	4.0	100.6	64.8	102.1	94.0	102.6	708.6	9986
SV 883		269.4	95.9	9033.9	90.8	16.3	96.5	89.2	99.6	33.6	94.6	5.0	110.2	3.4	98.9	3.6	91.7	62.2	98.0	93.1	88.2	607.9	883
SV RR862		272.6	97.0	9151.2	92.0	16.5	97.7	89.5	99.9	33.6	94.6	5.2	114.6	3.4	98.9	3.7	93.3	62.8	99.0	95.8	90.8	629.5	862

*__Revenue per Ton__ and **Revenue per Acre** figures were produced using the payment calculation with factors released on Oct. 21, 2022 for the final 2021 crop payment.

** Lower numbers are better for all disease nursery ratings.

***ESTESA is a unitless SMBSC parameter that correlates to grower payment and revenue per acre. Higher is better.

2020-2022 Disease Nursery Data for Aphanomyces, Cercospora, and Rhizoctonia

	Aphanomyces Root Ratings					Cercospora Leafspot Ratings					Rhizoctonia Root Ratings				
	2022	2021	2020	**2021-2022**	**2020-2022**	2022	2021	2020	**2021-2022**	**2020-2022**	2022	2021	2020	**2021-2022**	**2020-2022**
Variety	Root	Root	Root	**2 Year Mean**	**3 Year Mean**	CLS	CLS	CLS	**2 Year Mean**	**3 Year Mean**	Root	Root	Root	**2 Year Mean**	**3 Year Mean**
Description	Rating	Rating	Rating	Root Rating	Root Rating	Rating	Rating	Rating	Foliar Rating	Foliar Rating	Rating	Rating	Rating	Root Rating	Root Rating
Fully Approved Varieties															
Beta 9044	4.3	5.1	4.1	4.7	4.5	4.1	4.1	4.3	4.1	4.2	3.8	3.9	4.1	3.9	3.9
Beta 9098	4.7	4.9	4.9	4.8	4.9	1.9	2.3	2.7	2.1	2.3	4.4	4.8	4.4	4.6	4.5
Crystal M002	4.3	4.9	4.1	4.6	4.4	1.7	1.8	2.1	1.8	1.9	4.3	4.4	4.5	4.3	4.4
Crystal M028	4.3	4.4	4.2	4.4	4.3	3.7	3.9	4.0	3.8	3.9	4.1	4.1	4.1	4.1	4.1
Hilleshog 2327	4.6	4.1	4.2	4.3	4.3	4.1	4.0	4.2	4.0	4.1	3.8	3.7	4.1	3.8	3.9
Hilleshog 2379	4.3	4.3	4.2	4.3	4.3	4.1	4.1	4.5	4.1	4.2	3.8	4.3	4.2	4.0	4.1
SV 881	5.0	3.9	4.3	4.4	4.4	3.9	4.0	4.2	4.0	4.0	3.8	4.0	4.3	3.9	4.0
SV RR863	4.8	3.8	4.5	4.3	4.4	4.0	4.1	4.1	4.0	4.1	3.5	3.7	4.1	3.6	3.8
Test Market Varieties															
Beta 9088	4.6	4.8	4.2	4.7	4.5	4.4	4.1	4.3	4.3	4.3	4.0	4.0	4.1	4.0	4.0
Beta 9124	5.0	5.0		5.0		2.3	2.6		2.4		4.5	4.4		4.4	
Beta 9131	4.6	5.0		4.8		2.0	2.3		2.1		3.5	3.5		3.5	
Beta 9155	4.1	4.2		4.2		2.4	2.9		2.6		3.2	3.6		3.4	
Crystal M106	3.6	4.2		3.9		4.1	3.9		4.0		3.7	4.0		3.8	
Crystal M168	4.0	4.6		4.3		2.0	2.2		2.1		4.3	4.3		4.3	
Hilleshog 2395	5.0	4.2		4.6		4.4	4.3		4.3		4.0	4.4		4.2	
Hilleshog 2398	4.5	4.6		4.6		3.8	3.8		3.8		4.1	3.9		4.0	
Hilleshog 2399	5.1	4.9		5.0		4.4	4.2		4.3		4.0	4.0		4.0	
APH Specialty Approved															
Crystal M977	3.5	4.2	4.0	3.9	3.9	4.7	4.3	4.6	4.5	4.5	3.3	3.6	3.8	3.4	3.6
Crystal M089	3.9	4.2	4.4	4.1	4.2	2.2	2.5	2.7	2.3	2.5	3.5	3.5	3.9	3.5	3.7
RHC Specialty Approved															
Crystal M977	3.5	4.2	4.0	3.9	3.9	4.7	4.3	4.6	4.5	4.5	3.3	3.6	3.8	3.4	3.6
Crystal M089	3.9	4.2	4.4	4.1	4.2	2.2	2.5	2.7	2.3	2.5	3.5	3.5	3.9	3.5	3.7

Aphanomyces	Cercospora	Rhizoctonia
Aphanomyces Ratings from SMBSC Nursery at Renville and KWS Nursery in Shakopee.	Cercospora Ratings from SMBSC Nursery in Renville and KWS Nursery near Randolph MN.	Rhizoctonia Ratings from SMBSC Nursery at Renville and BSDF Nursery in Michigan
Ratings are on scale of 1 - 9.	**Ratings are on scale of 1-9.**	**Ratings are on scale of 1 - 7.**

** Lower Ratings mean more resistant to disease and are shown in green font.

**Higher Ratings mean more susceptible to disease and are shown in red font.

SMBSC Agricultural Staff Variety Strip Trial - Summary

Strip Trial Means Table

Variety	Stand Count 28 DAP Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Acre	Percent of Mean Revenue per Acre
Beta 9044	158	17.5	89.8	27.3	7946.1	102.3%
Beta 9124	155	16.9	89.0	29.2	8147.1	101.0%
Beta 9155	167	16.2	89.1	31.5	8481.1	102.3%
Crystal M028	161	17.2	89.5	26.4	7578.1	94.9%
Crystal M168	161	16.8	88.7	29.9	8259.4	101.9%
Hilleshog 2379	159	16.8	89.5	28.1	7767.6	96.7%
Mean	160.2	16.9	89.3	28.7	8029.9	100.0
%CV	8.3	3.2	1.0	5.8	6.6	7.9
PR>F	0.5511	0.0006	0.1192	<.0001	0.0094	0.2053
LSD (0.05)	12.7	0.5	0.9	1.6	502.8	7.5
Reps	9	9	9	9	9	9

Combined data from 9 locations with each location considered a replicate.
Locations: Renville, Redwood, Olivia, Murdock, Raymond, Hector, Bird Island, Benson, and Maynard.
Revenue is calculated using the 2021 crop payment calculator, utilizing values released Oct. 21, 2022

SMBSC Variety Strip Trial - Renville

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	171	18.3	89.4	31.2	305.3	9530	105.1%	Beta 9044
Beta 9124	164	17.4	88.7	31.9	286.6	9154	97.3%	Beta 9124
Beta 9155	195	16.7	88.4	34.2	272.0	9293	95.4%	Beta 9155
Crystal M028	181	18.6	88.4	31.9	305.3	9746	107.5%	Crystal M028
Crystal M168	160	17.0	89.3	32.4	282.3	9153	96.3%	Crystal M168
Hilleshog 2379	164	17.2	88.3	33.4	280.5	9376	98.3%	Hilleshog 2379
Beta 9986*	186	16.4	87.6	34.6	263.1	9106	91.4%	Beta 9986*
Average	**173**	**17.5**	**88.7**	**32.5**	**288.6**	**9375**	**100.0%**	**Average**

Planted: May 22, 2022
Harvested: October 11, 2022
Agriculturalist: Cody Bakker

*Denotes variety shown with final data, but not included with average/statistcal analysis

SMBSC Variety Strip Trial - Redwood

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	174	18.0	89.7	31.7	301.6	9553	98.8%	Beta 9044
Beta 9124	153	17.2	89.2	36.2	285.3	10336	103.4%	Beta 9124
Beta 9155	160	16.7	89.5	37.8	277.6	10492	103.1%	Beta 9155
Crystal M028	172	17.9	90.4	32.5	302.3	9811	101.6%	Crystal M028
Crystal M168	145	17.5	89.1	33.6	290.0	9758	98.6%	Crystal M168
Hilleshog 2379	153	16.9	89.4	33.9	281.1	9531	94.4%	Hilleshog 2379
Average	**159**	**17.4**	**89.6**	**34.3**	**289.6**	**9914**	**100.0%**	**Average**

Planted: May 7, 2022
Harvested: September 29, 2022
Agriculturalist: Chris Dunsmore

SMBSC Variety Strip Trial - Olivia

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	173	17.2	89.6	31.0	287.0	8895	99.5%	Beta 9044
Beta 9124	182	16.6	89.5	34.3	275.6	9439	102.9%	Beta 9124
Beta 9155	203	16.0	89.3	37.5	265.2	9937	105.5%	Beta 9155
Crystal M028	181	16.9	89.4	31.5	280.5	8850	97.6%	Crystal M028
Crystal M168	206	16.5	89.8	33.2	274.6	9129	99.3%	Crystal M168
Hilleshog 2379	188	16.1	89.2	33.7	265.5	8961	95.2%	Hilleshog 2379
Average	**189**	**16.6**	**89.5**	**33.5**	**274.7**	**9202**	**100.0%**	**Average**

Planted: May 21, 2022
Harvested: September 27, 2022
Agriculturalist: Chris Dunsmore

SMBSC Variety Strip Trial - Belgrade**

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	186	17.9	89.0	32.3	296.0	9573	102.5%	Beta 9044
Beta 9124	186	17.7	88.9	30.6	292.8	8955	95.2%	Beta 9124
Beta 9155	188	16.7	88.5	35.8	273.2	9791	99.7%	Beta 9155
Crystal M028	196	17.4	89.0	32.8	287.5	9419	99.1%	Crystal M028
Crystal M168	200	18.1	89.5	38.4	301.3	11564	125.1%	Crystal M168
Hilleshog 2379	182	16.8	87.7	30.8	270.8	8334	84.3%	Hilleshog 2379
Crystal M002	184	17.1	88.4	33.5	278.8	9349	96.4%	Crystal M002
Hilleshog 2327	158	16.8	88.0	35.4	272.0	9633	97.7%	Hilleshog 2327
Average	**185**	**17.3**	**88.6**	**33.7**	**284.1**	**9577**	**100.0%**	**Average**

Planted: April 29, 2022
Harvested: October 17, 2022
Agriculturalist: Jared Kelm

**Denotes an irrigated strip trial and data not used in combined "Variety Strip Trial Mean Table"

SMBSC Variety Strip Trial - Raymond

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	140	18.0	90.3	26.6	302.5	8061	103.7%	Beta 9044
Beta 9124	134	16.9	88.7	28.6	277.0	7925	96.6%	Beta 9124
Beta 9155	136	16.3	89.2	31.5	269.4	8489	101.6%	Beta 9155
Crystal M028	142	17.2	90.1	26.3	288.8	7588	95.0%	Crystal M028
Crystal M168	132	17.5	88.9	29.3	288.8	8468	106.0%	Crystal M168
Hilleshog 2379	116	16.7	89.1	28.9	275.7	7982	97.0%	Hilleshog 2379
Average	**133**	**17.1**	**89.4**	**28.6**	**283.7**	**8086**	**100.0%**	**Average**

Planted: May 26, 2022
Harvested: October 12, 2022
Agriculturalist: Jared Kelm

SMBSC Variety Strip Trial - Murdock

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	170	15.7	90.6	27.8	264.0	7343	100.1%	Beta 9044
Beta 9124	175	16.0	90.4	28.7	269.1	7726	106.7%	Beta 9124
Beta 9155	179	14.8	90.2	31.9	246.6	7856	101.7%	Beta 9155
Crystal M028	175	16.1	90.1	23.6	268.5	6344	87.5%	Crystal M028
Crystal M168	160	15.4	90.1	30.4	256.1	7781	103.7%	Crystal M168
Hilleshog 2379	223	15.0	90.3	30.5	250.8	7648	100.3%	Hilleshog 2379
Average	**180**	**15.5**	**90.3**	**28.8**	**259.2**	**7450**	**100.0%**	**Average**

Planted: May 23 ,2022
Harvested: September 22, 2022
Agriculturalist: Bill Luepke

SMBSC Variety Strip Trial - Hector

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	190	18.2	90.2	20.7	306.0	6331	104.5%	Beta 9044
Beta 9124	188	17.5	88.5	20.4	287.5	5870	93.4%	Beta 9124
Beta 9155	196	16.5	88.2	22.0	268.1	5886	89.5%	Beta 9155
Crystal M028	182	18.8	92.3	18.9	326.7	6186	105.7%	Crystal M028
Crystal M168	196	16.8	87.1	22.4	268.5	6027	91.7%	Crystal M168
Hilleshog 2379	204	17.8	91.1	23.2	303.1	7018	115.2%	Hilleshog 2379
Hilleshog 2327*	200	16.6	88.0	22.5	268.4	6034	91.8%	Hilleshog 2327*
Hilleshog Exp A*	206	16.3	87.3	20.7	260.4	5390	80.2%	Hilleshog Exp A*
Hilleshog Exp B*	202	17.2	89.5	21.3	286.4	6101	96.8%	Hilleshog Exp B*
Average	**193**	**17.6**	**89.6**	**21.3**	**293.3**	**6220**	**100.0%**	**Average**

Planted: May 24, 2022
Harvested: October 17, 2022
Agriculturalist: Griffin Schaub

*Denotes variety shown with final data, but not included with average/statistcal analysis

SMBSC Variety Strip Trial - Bird Island

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	118	17.3	87.6	19.1	279.4	5326	105.0%	Beta 9044
Beta 9124	130	16.2	86.4	21.6	254.9	5510	101.8%	Beta 9124
Beta 9155	121	15.2	86.9	24.6	241.1	5928	104.8%	Beta 9155
Crystal M028	125	15.3	87.0	19.6	243.8	4791	85.5%	Crystal M028
Crystal M168	141	15.8	85.8	23.8	246.5	5870	105.7%	Crystal M168
Hilleshog 2379	118	16.8	87.6	18.7	270.2	5050	97.3%	Hilleshog 2379
Average	**126**	**16.1**	**86.9**	**21.2**	**256.0**	**5412**	**100.0%**	**Average**

Planted: May 28, 2022
Harvested: October 16, 2022
Agriculturalist: Dylan Swanson

SMBSC Variety Strip Trial - Benson

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	75	19.5	92.6	25.2	341.6	8607	106.2%	Beta 9044
Beta 9124	84	17.6	89.9	30.6	294.9	9036	103.1%	Beta 9124
Beta 9155	94	17.6	91.5	33.6	301.6	10124	117.0%	Beta 9155
Crystal M028	100	18.2	89.6	26.0	303.3	7891	91.5%	Crystal M028
Crystal M168	96	18.2	89.5	30.1	303.7	9146	106.1%	Crystal M168
Hilleshog 2379	80	17.4	91.0	22.4	296.7	6642	76.1%	Hilleshog 2379
Average	**88**	**18.1**	**90.7**	**28.0**	**307.0**	**8574**	**100.0%**	**Average**

Planted: May 27, 2022
Harvested: October 15, 2022
Agriculturalist: Scott Thaden

SMBSC Variety Strip Trial - Appleton****

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	158	19.1	90.4	25.5	322.8	8245	103.4%	Beta 9044
Beta 9124	170	19.2	90.5	24.5	325.3	7959	100.2%	Beta 9124
Beta 9155	191	18.4	90.2	25.5	310.6	7933	97.5%	Beta 9155
Crystal M028	148	18.7	90.2	25.3	314.8	7958	98.5%	Crystal M028
Crystal M168	191	18.6	90.1	23.9	313.7	7493	92.5%	Crystal M168
Hilleshog 2379	206	18.9	90.4	26.7	320.6	8554	106.9%	Hilleshog 2379
Crystal M002	168	18.4	90.0	25.3	309.8	7832	96.1%	Crystal M002
Hilleshog 2327	171	18.6	90.1	27.2	313.0	8508	105.0%	Hilleshog 2327
Average	**175**	**18.7**	**90.2**	**25.5**	**316.3**	**8060**	**100.0%**	**Average**

Planted: May 4, 2022
Harvested: September 30, 2022
Agriculturalist: Scott Thaden

**Denotes an irrigated strip trial and data not used in combined "Variety Strip Trial Mean Table"

SMBSC Variety Strip Trial - Maynard

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9044	200	16.8	90.6	29.3	283.9	8318	105.5%	Beta 9044
Beta 9124	182	16.8	89.2	30.0	277.4	8328	104.1%	Beta 9124
Beta 9155	216	16.4	88.9	31.0	268.8	8324	101.8%	Beta 9155
Crystal M028	194	15.7	88.4	27.5	254.7	6997	82.3%	Crystal M028
Crystal M168	214	16.3	88.8	33.6	268.0	9003	109.9%	Crystal M168
Hilleshog 2379	188	16.8	89.0	27.7	277.7	7700	96.3%	Hilleshog 2379
Average	**199**	**16.5**	**89.2**	**29.8**	**271.7**	**8112**	**100.0%**	**Average**

Planted: May 23, 2022
Harvested: September 26, 2022
Agriculturalist: Charles Tvedt

Hector OVT

Entry	Name	Tons		Sugar		Percent ES		EST		ESA		Emergence		Purity	
		Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean
1	SV RR863	36.05	98.66	16.62	100.06	13.86	100.58	277.19	100.54	9,928.9	98.55	51.74	87.41	89.85	100.40
2	Beta 9131	37.32	102.13	16.92	101.87	14.19	102.98	283.74	102.92	10,609.0	105.30	61.24	103.46	90.08	100.66
3	Hilleshog 2398	36.75	100.57	16.22	97.65	13.25	96.15	265.02	96.13	9,696.4	96.25	62.6	105.76	88.66	99.07
4	Hilleshog 2447	36.23	99.15	16.34	98.37	13.58	98.55	271.6	98.51	9,927.8	98.54	37.27	62.97	89.56	100.08
5	Hilleshog 2450	34.78	95.18	16.22	97.65	13.41	97.31	268.14	97.26	9,350.4	92.81	51.82	87.55	89.29	99.78
6	Baseline 10 Crystal M623	36.22	99.12	16.97	102.17	14.12	102.47	282.44	102.44	10,183.9	101.08	63.16	106.71	89.55	100.07
7	SV 825	39.12	107.06	15.93	95.91	13.21	95.86	264.25	95.85	10,359.4	102.83	62.21	105.10	89.74	100.28
8	Filler #3	36.55	100.03	16.54	99.58	13.81	100.22	276.27	100.21	10,160.1	100.85	50.58	85.45	89.96	100.53
9	Beta 9155	39.49	108.07	15.95	96.03	13.13	95.28	262.51	95.22	10,310.6	102.34	64.53	109.02	89.1	99.56
10	SV 881	37.46	102.52	16.44	98.98	13.53	98.19	270.58	98.14	10,122.4	100.47	58.76	99.27	88.94	99.39
11	Crystal M265	37.96	103.89	16.87	101.57	13.84	100.44	276.82	100.41	10,440.0	103.63	58.16	98.26	88.76	99.18
12	Baseline 12 Hilleshog 2327	36.61	100.19	16.2	97.53	13.44	97.53	268.81	97.50	9,807.1	97.34	52.07	87.97	89.49	100.00
13	Baseline 9 SV RR863	35.18	96.28	16.29	98.07	13.52	98.11	270.36	98.06	9,440.9	93.71	60.95	102.97	89.66	100.19
14	Beta 9088	35.07	95.98	16.66	100.30	13.69	99.35	273.88	99.34	9,811.6	97.39	49.62	83.83	88.88	99.32
15	Crystal M168	36.83	100.79	17.02	102.47	14.18	102.90	283.54	102.84	10,336.2	102.60	68.34	115.46	89.64	100.17
16	Beta 9044	33.61	91.98	17.11	103.01	14.31	103.85	286.18	103.80	9,495.1	94.25	60.9	102.89	89.9	100.46
17	Crystal M272	36.73	100.52	16.95	102.05	14.17	102.83	283.41	102.80	10,560.4	104.82	61.16	103.33	89.92	100.48
18	Hilleshog 2399	34.26	93.76	15.94	95.97	13.1	95.07	261.99	95.03	9,052.6	89.85	44.75	75.60	88.97	99.42
19	Baseline 11 Beta 9780	35.93	98.33	16.67	100.36	13.81	100.22	276.1	100.15	9,852.8	97.80	62.64	105.83	89.31	99.80
20	Hilleshog 2379	36.75	100.57	16.54	99.58	13.57	98.48	271.47	98.47	9,929.5	98.56	61.66	104.17	88.95	99.40
21	Filler #1	35.02	95.84	17.25	103.85	14.38	104.35	287.58	104.31	10,066.1	99.91	58.37	98.61	89.62	100.15
22	Beta 9284	38.29	104.79	17.47	105.18	14.68	106.53	293.52	106.46	11,230.4	111.47	64.27	108.58	90.14	100.73
23	Filler #2	35.21	96.36	17.27	103.97	14.49	105.15	289.76	105.10	10,201.2	101.26	58.87	99.46	90.2	100.79
24	Crystal M977	40.22	110.07	16.71	100.60	13.92	101.02	278.4	100.98	11,145.2	110.63	56.68	95.76	89.79	100.34
25	Crystal M002	36.27	99.26	16.29	98.07	13.47	97.75	269.32	97.69	9,809.1	97.36	62.31	105.27	89.22	99.70
26	Beta 9258	38.07	104.19	16.62	100.06	13.85	100.51	276.91	100.44	10,513.5	104.36	64.9	109.65	89.79	100.34
27	Crystal M223	35.88	98.19	16.13	97.11	13.13	95.28	262.59	95.24	9,468.4	93.98	62.61	105.78	88.19	98.55
28	SV 883	33.42	91.46	16.18	97.41	13.24	96.08	264.71	96.01	8,831.6	87.66	59.53	100.57	88.7	99.12
29	Hilleshog 2395	36.82	100.77	16.09	96.87	13.32	96.66	266.49	96.66	9,804.2	97.31	61.24	103.46	89.47	99.98
30	Beta 9291	35.96	98.41	16.75	100.84	13.98	101.45	279.53	101.39	10,163.7	100.88	58.77	99.29	89.83	100.38
31	Beta 9124	36.55	100.03	16.94	101.99	14.04	101.89	280.88	101.88	10,446.4	103.69	63.9	107.96	89.33	99.82
32	Beta 9986	38.73	105.99	16.93	101.93	14.18	102.90	283.56	102.85	10,915.6	108.35	61.62	104.11	90.09	100.67
33	Hilleshog 2448	35.87	98.17	16.4	98.74	13.6	98.69	272.05	98.68	9,755.3	96.83	48.13	81.31	89.46	99.97
34	Beta 9098	36.89	100.96	16.57	99.76	13.73	99.64	274.62	99.61	10,109.4	100.34	62.46	105.52	89.54	100.06
35	Crystal M089	40.2	110.02	15.93	95.91	13.12	95.21	262.46	95.20	10,520.0	104.42	64.01	108.14	89.1	99.56
36	Crystal M028	35.07	95.98	17.29	104.09	14.52	105.37	290.32	105.30	10,303.4	102.27	67.69	114.36	90.17	100.76
37	Hilleshog 2449	36.44	99.73	17.22	103.67	14.42	104.64	288.32	104.58	10,501.7	104.24	57.1	96.47	89.92	100.48
38	Crystal M106	38.9	106.46	17.09	102.89	14.3	103.77	285.98	103.73	11,094.5	110.12	67.75	114.46	89.93	100.49
39	Beta 9207	34.55	94.55	16.47	99.16	13.62	98.84	272.45	98.82	9,419.2	93.49	62.82	106.13	89.4	99.90
40	Hilleshog 2327	36.55	100.03	16.49	99.28	13.77	99.93	275.32	99.86	10,104.5	100.30	55.95	94.53	89.82	100.37
41	SV RR862	33.83	92.58	16.46	99.10	13.64	98.98	272.79	98.94	9,164.6	90.97	64.58	109.11	89.5	100.01
42	Crystal M260	36.94	101.09	16.84	101.38	13.87	100.65	277.48	100.65	10,192.7	101.17	58.36	98.60	88.94	99.39
	GRAND MEAN	36.54		16.61		13.78		275.7		10,074.7		59.19		89.49	
	Residual	2.01		0.18		0.23		90.49		246,656.92		61.64		0.94	
	%CV	4.06		2.58		3.5		3.5		5.05		13.68		1.09	
	LSD	1.69		0.49		0.55		11.01		579.69		9.23		1.11	

Lake Lillian OVT

Entry	Name	Tons Mean	Tons % Mean	Sugar Mean	Sugar % Mean	Percent ES Mean	Percent ES % Mean	EST Mean	EST % Mean	ESA Mean	ESA % Mean	Emergence Mean	Emergence % Mean	Purity Mean	Purity % Mean
1	SV RR863	35.26	99.83	14.93	98.35	12.38	98.02	247.51	97.97	8,738.1	97.79	51.81	89.59	89.85	99.79
2	Beta 9131	35.95	101.78	15.41	101.52	12.88	101.98	257.67	101.99	9,260.7	103.64	51.26	88.64	90.28	100.27
3	Hilleshog 2398	35.19	99.63	15.13	99.67	12.56	99.45	251.30	99.47	8,852.9	99.07	57.19	98.89	89.96	99.91
4	Hilleshog 2447	33.50	94.85	14.63	96.38	12.22	96.75	244.34	96.71	8,152.3	91.23	39.64	68.55	90.37	100.37
5	Hilleshog 2450	35.56	100.68	14.97	98.62	12.61	99.84	252.12	99.79	8,952.7	100.19	51.08	88.33	90.96	101.02
6	Baseline 10 Crystal M623	33.29	94.25	15.52	102.24	12.99	102.85	259.86	102.85	8,679.5	97.13	56.17	97.13	90.38	100.38
7	SV 825	34.14	96.66	14.61	96.25	12.03	95.25	240.69	95.27	8,422.2	94.25	52.57	90.90	89.53	99.43
8	Filler #3	35.19	99.63	14.91	98.22	12.39	98.10	247.87	98.11	8,708.3	97.46	53.13	91.87	90.05	100.01
9	Beta 9155	36.98	104.70	15.11	99.54	12.59	99.68	251.78	99.66	9,341.4	104.54	63.89	110.48	90.14	100.11
10	SV 881	34.01	96.29	15.29	100.72	12.74	100.87	254.90	100.89	8,756.2	97.99	53.31	92.18	90.18	100.16
11	Crystal M265	34.55	97.82	14.97	98.62	12.45	98.57	248.98	98.55	8,596.7	96.21	59.59	103.04	90.05	100.01
12	Baseline 12 Hilleshog 2327	36.12	102.27	14.87	97.96	12.30	97.39	246.04	97.38	8,915.7	99.78	51.87	89.69	89.77	99.70
13	Baseline 9 SV RR863	36.78	104.13	14.99	98.75	12.50	98.97	249.96	98.94	9,154.5	102.45	56.71	98.06	90.21	100.19
14	Beta 9088	34.37	97.31	15.63	102.96	13.05	103.33	260.93	103.28	8,880.7	99.38	57.34	99.15	90.12	100.09
15	Crystal M168	36.18	102.43	14.85	97.83	12.27	97.15	245.40	97.13	8,902.5	99.63	67.83	117.29	89.70	99.62
16	Beta 9044	34.28	97.06	15.62	102.90	13.02	103.09	260.33	103.04	8,923.4	99.86	54.89	94.92	89.99	99.94
17	Crystal M272	35.36	100.11	15.82	104.22	13.17	104.28	263.49	104.29	9,299.5	104.07	62.17	107.50	89.91	99.86
18	Hilleshog 2399	34.71	98.27	14.47	95.32	12.04	95.33	240.83	95.32	8,393.2	93.93	46.22	79.92	90.30	100.29
19	Baseline 11 Beta 9780	35.10	99.38	15.14	99.74	12.57	99.52	251.35	99.49	8,798.0	98.46	62.93	108.82	89.89	99.83
20	Hilleshog 2379	34.87	98.73	15.18	100.00	12.67	100.32	253.32	100.27	8,845.9	99.00	49.29	85.23	90.22	100.20
21	Filler #1	34.32	97.17	16.07	105.86	13.53	107.13	270.55	107.08	9,263.1	103.66	55.27	95.57	90.64	100.67
22	Beta 9284	36.18	102.43	15.79	104.02	13.21	104.59	264.27	104.60	9,588.0	107.30	63.47	109.75	90.26	100.24
23	Filler #2	34.77	98.44	15.87	104.55	13.21	104.59	264.29	104.61	9,198.7	102.94	60.74	105.03	89.89	99.83
24	Crystal M977	38.28	108.38	15.32	100.92	12.79	101.27	255.87	101.27	9,791.0	109.57	59.69	103.22	90.26	100.24
25	Crystal M002	35.42	100.28	14.96	98.55	12.43	98.42	248.63	98.41	8,825.5	98.77	59.31	102.56	89.99	99.94
26	Beta 9258	35.20	99.66	15.26	100.53	12.72	100.71	254.34	100.67	8,886.2	99.45	60.79	105.12	90.13	100.10
27	Crystal M223	35.92	101.70	14.71	96.90	12.13	96.04	242.63	96.03	8,799.9	98.48	67.20	116.20	89.65	99.57
28	SV 883	32.91	93.18	15.00	98.81	12.41	98.26	248.14	98.21	8,215.7	91.94	53.80	93.03	89.65	99.57
29	Hilleshog 2395	34.28	97.06	14.70	96.84	12.17	96.36	243.36	96.32	8,382.3	93.81	69.51	120.20	89.81	99.74
30	Beta 9291	36.51	103.37	15.61	102.83	12.99	102.85	259.87	102.86	9,475.1	106.04	55.60	96.14	89.93	99.88
31	Beta 9124	38.06	107.76	15.44	101.71	12.86	101.82	257.12	101.77	9,781.4	109.46	65.24	112.81	89.98	99.93
32	Beta 9986	40.56	114.84	14.95	98.48	12.44	98.50	248.71	98.44	10,041.0	112.37	61.03	105.53	90.05	100.01
33	Hilleshog 2448	31.79	90.01	14.47	95.32	12.01	95.09	240.20	95.07	7,592.8	84.97	53.16	91.92	90.00	99.96
34	Beta 9098	34.11	96.57	15.09	99.41	12.50	98.97	249.90	98.91	8,635.1	96.64	61.52	106.38	89.84	99.78
35	Crystal M089	39.46	111.72	15.19	100.07	12.63	100.00	252.58	99.97	9,929.3	111.12	63.58	109.94	90.04	100.00
36	Crystal M028	34.70	98.24	15.78	103.95	13.21	104.59	264.16	104.56	9,167.7	102.60	62.23	107.61	90.25	100.23
37	Hilleshog 2449	33.64	95.24	15.53	102.31	13.05	103.33	260.92	103.27	8,855.3	99.10	54.65	94.50	90.56	100.58
38	Crystal M106	37.01	104.78	15.40	101.45	12.88	101.98	257.56	101.94	9,460.9	105.88	70.60	122.08	90.34	100.33
39	Beta 9207	35.52	100.57	15.21	100.20	12.61	99.84	252.16	99.81	8,966.1	100.34	62.83	108.65	89.80	99.73
40	Hilleshog 2327	34.44	97.51	14.99	98.75	12.43	98.42	248.61	98.40	8,709.5	97.47	53.34	92.24	89.90	99.84
41	SV RR862	33.24	94.11	14.96	98.55	12.35	97.78	247.09	97.80	8,270.7	92.56	48.70	84.21	89.70	99.62
42	Crystal M260	35.76	101.25	15.30	100.79	12.59	99.68	251.81	99.67	8,889.5	99.48	67.56	116.83	89.19	99.06
	GRAND MEAN	35.32		15.18		12.63		252.65		8,935.7		57.83		90.04	
	Residual	4.41		0.16		0.20		79.05		395,936.99		65.38		0.63	
	%CV	6.17		2.67		3.54		3.54		7.27		14.56		0.89	
	LSD (0.05)	2.48		0.46		0.51		10.21		740.40		9.60		0.91	

Murdock OVT

Entry	Name	Tons		Sugar		Percent ES		EST		ESA		Emergence		Purity	
		Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean
1	SV RR863	37.59	97.92	16.18	97.29	13.12	96.83	262.31	96.82	9,837.0	94.66	67.70	100.45	88.11	99.84
2	Beta 9131	41.09	107.03	17.02	102.35	13.98	103.17	279.70	103.24	11,487.8	110.55	62.67	92.98	88.74	100.56
3	Hilleshog 2398	36.41	94.84	16.19	97.35	13.16	97.12	263.27	97.17	9,627.6	92.65	65.93	97.82	88.25	100.00
4	Hilleshog 2447	41.45	107.97	15.67	94.23	12.57	92.77	251.48	92.82	10,284.8	98.97	47.20	70.03	87.51	99.16
5	Hilleshog 2450	37.29	97.13	16.33	98.20	13.23	97.64	264.51	97.63	9,847.8	94.77	59.83	88.77	88.01	99.73
6	Baseline 10 Crystal M623	38.34	99.87	16.98	102.10	13.81	101.92	276.13	101.92	10,539.7	101.43	70.68	104.87	88.10	99.83
7	SV 825	40.83	106.36	16.14	97.05	13.19	97.34	263.72	97.34	10,756.5	103.51	65.58	97.30	88.52	100.31
8	Filler #3	37.71	98.23	16.26	97.78	13.19	97.34	263.88	97.40	9,985.8	96.10	63.31	93.93	88.14	99.88
9	Beta 9155	41.34	107.68	16.36	98.38	13.39	98.82	267.89	98.88	11,083.9	106.66	71.07	105.45	88.62	100.42
10	SV 881	38.70	100.81	16.53	99.40	13.47	99.41	269.35	99.42	10,421.8	100.29	70.29	104.29	88.31	100.07
11	Crystal M265	37.72	98.25	16.93	101.80	13.73	101.33	274.58	101.35	10,350.9	99.61	67.05	99.48	87.99	99.71
12	Baseline 12 Hilleshog 2327	38.93	101.41	16.63	100.00	13.53	99.85	270.56	99.86	10,496.2	101.01	65.09	96.57	88.17	99.91
13	Baseline 9 SV RR863	37.45	97.55	16.04	96.45	12.93	95.42	258.66	95.47	9,655.6	92.92	67.75	100.52	87.75	99.43
14	Beta 9088	38.61	100.57	17.39	104.57	14.27	105.31	285.43	105.35	11,003.6	105.89	66.74	99.02	88.58	100.37
15	Crystal M168	38.39	100.00	16.47	99.04	13.38	98.75	267.62	98.78	10,273.8	98.87	71.56	106.17	88.17	99.91
16	Beta 9044	35.98	93.72	18.01	108.30	14.89	109.89	297.72	109.89	10,640.6	102.40	72.05	106.90	88.96	100.80
17	Crystal M272	38.61	100.57	17.12	102.95	13.95	102.95	279.07	103.00	10,801.8	103.95	65.37	96.99	88.20	99.94
18	Hilleshog 2399	36.96	96.28	15.72	94.53	12.67	93.51	253.47	93.56	9,367.4	90.15	61.26	90.89	87.81	99.50
19	Baseline 11 Beta 9780	38.75	100.94	16.77	100.84	13.63	100.59	272.55	100.60	10,579.3	101.81	75.02	111.31	88.04	99.76
20	Hilleshog 2379	38.31	99.79	16.74	100.66	13.65	100.74	273.05	100.78	10,454.7	100.61	65.88	97.74	88.32	100.08
21	Filler #1	35.95	93.64	18.03	108.42	14.92	110.11	298.43	110.15	10,745.8	103.41	67.81	100.61	89.03	100.88
22	Beta 9284	38.28	99.71	17.93	107.82	14.82	109.37	296.31	109.37	11,437.7	110.07	60.16	89.26	88.92	100.76
23	Filler #2	37.18	96.85	17.14	103.07	14.10	104.06	282.10	104.12	10,511.1	101.15	73.36	108.84	88.84	100.67
24	Crystal M977	42.19	109.90	16.74	100.66	13.72	101.25	274.48	101.31	11,550.8	111.16	68.98	102.34	88.68	100.49
25	Crystal M002	40.30	104.98	16.76	100.78	13.73	101.33	274.58	101.35	11,064.3	106.47	73.02	108.34	88.63	100.43
26	Beta 9258	39.19	102.08	16.56	99.58	13.51	99.70	270.23	99.74	10,604.7	102.05	73.40	108.90	88.37	100.14
27	Crystal M223	37.68	98.15	16.37	98.44	13.29	98.08	265.83	98.12	9,938.1	95.64	67.48	100.12	88.18	99.92
28	SV 883	35.17	91.61	16.09	96.75	13.01	96.01	260.22	96.05	9,154.9	88.10	69.70	103.41	87.94	99.65
29	Hilleshog 2395	38.01	99.01	16.37	98.44	13.34	98.45	266.74	98.45	10,137.1	97.55	63.02	93.50	88.35	100.11
30	Beta 9291	38.45	100.16	17.14	103.07	13.93	102.80	278.53	102.81	10,679.7	102.77	74.37	110.34	88.03	99.75
31	Beta 9124	37.14	96.74	16.95	101.92	13.77	101.62	275.39	101.65	10,230.2	98.45	68.68	101.90	88.04	99.76
32	Beta 9986	41.15	107.19	15.86	95.37	12.85	94.83	256.96	94.84	10,581.7	101.83	63.71	94.53	88.11	99.84
33	Hilleshog 2448	37.19	96.87	16.23	97.59	13.23	97.64	264.51	97.63	9,843.5	94.73	64.65	95.92	88.38	100.15
34	Beta 9098	38.66	100.70	16.12	96.93	12.98	95.79	259.70	95.86	10,088.1	97.08	70.06	103.95	87.67	99.34
35	Crystal M089	41.33	107.66	16.00	96.21	13.01	96.01	260.13	96.01	10,736.6	103.32	73.98	109.76	88.27	100.02
36	Crystal M028	37.23	96.98	17.43	104.81	14.25	105.17	284.97	105.18	10,619.9	102.20	67.00	99.41	88.33	100.09
37	Hilleshog 2449	37.97	98.91	16.36	98.38	13.28	98.01	265.57	98.02	10,105.3	97.25	66.80	99.11	88.11	99.84
38	Crystal M106	40.30	104.98	16.71	100.48	13.61	100.44	272.21	100.47	10,937.2	105.25	71.61	106.25	88.25	100.00
39	Beta 9207	36.75	95.73	16.80	101.02	13.70	101.11	274.09	101.17	10,093.7	97.13	75.87	112.57	88.31	100.07
40	Hilleshog 2327	38.57	100.47	16.29	97.96	13.27	97.93	265.33	97.93	10,250.4	98.64	56.45	83.75	88.35	100.11
41	SV RR862	35.62	92.78	16.24	97.65	13.15	97.05	262.96	97.06	9,345.0	89.93	69.09	102.51	87.97	99.68
42	Crystal M260	37.43	97.50	17.03	102.41	13.75	101.48	274.99	101.50	10,291.0	99.03	69.57	103.22	87.64	99.31
	GRAND MEAN	38.39		16.63		13.55		270.93		10,391.5		67.40		88.25	
	Residual	1.20		0.21		0.24		96.96		232,911.24		43.02		0.54	
	%CV	3.00		2.83		3.76		3.76		4.81		10.22		0.86	
	LSD (0.05)	1.31		0.54		0.58		11.61		570.12		7.85		0.86	

Wood Lake OVT

Entry	Name	Tons Mean	Tons % Mean	Sugar Mean	Sugar % Mean	Percent ES Mean	Percent ES % Mean	EST Mean	EST % Mean	ESA Mean	ESA % Mean	Emergence Mean	Emergence % Mean	Purity Mean	Purity % Mean
1	SV RR863	34.85	106.12	18.29	96.47	15.50	96.57	310.05	96.59	10,669.3	101.43	61.57	89.79	90.30	99.93
2	Beta 9131	33.13	100.88	19.27	101.64	16.25	101.25	325.01	101.25	10,705.0	101.77	67.44	98.35	90.18	99.80
3	Hilleshog 2398	32.28	98.29	19.04	100.42	16.14	100.56	322.89	100.59	10,696.5	101.69	72.46	105.67	90.23	99.86
4	Hilleshog 2447	30.96	94.28	18.04	95.15	15.16	94.45	303.11	94.43	9,690.5	92.12	48.65	70.95	90.29	99.92
5	Hilleshog 2450	33.11	100.82	18.65	98.36	15.56	96.95	311.12	96.92	9,989.8	94.97	60.18	87.76	89.27	98.79
6	Baseline 10 Crystal M623	31.79	96.80	19.28	101.69	16.27	101.37	325.44	101.38	9,970.2	94.78	71.14	103.75	90.39	100.03
7	SV 825	35.97	109.53	18.70	98.63	15.75	98.13	315.04	98.14	11,225.4	106.72	73.19	106.74	90.12	99.73
8	Filler #3	35.11	106.91	17.83	94.04	14.86	92.59	297.11	92.56	10,374.3	98.63	69.81	101.81	89.56	99.11
9	Beta 9155	36.47	111.05	17.93	94.57	15.15	94.39	303.04	94.40	10,949.5	104.09	77.07	112.40	90.51	100.17
10	SV 881	34.78	105.91	18.57	97.94	15.69	97.76	313.74	97.74	11,011.9	104.69	65.46	95.46	90.20	99.82
11	Crystal M265	36.37	110.75	19.19	101.21	16.22	101.06	324.45	101.07	11,411.5	108.49	65.33	95.27	90.29	99.92
12	Baseline 12 Hilleshog 2327	31.38	95.55	18.89	99.63	16.03	99.88	320.64	99.89	10,252.7	97.47	60.46	88.17	90.56	100.22
13	Baseline 9 SV RR863	33.81	102.95	18.71	98.68	15.84	98.69	316.76	98.68	10,520.9	100.02	68.92	100.51	90.23	99.86
14	Beta 9088	30.63	93.27	19.55	103.11	16.62	103.55	332.46	103.57	10,411.0	98.97	68.87	100.44	90.79	100.48
15	Crystal M168	32.33	98.45	19.28	101.69	16.17	100.75	323.43	100.76	10,517.6	99.99	67.37	98.25	89.99	99.59
16	Beta 9044	31.19	94.98	19.43	102.48	16.57	103.24	331.32	103.21	10,305.6	97.97	74.17	108.17	90.91	100.61
17	Crystal M272	31.98	97.38	19.89	104.91	17.15	106.85	343.08	106.88	11,035.4	104.91	71.14	103.75	91.48	101.24
18	Hilleshog 2399	30.43	92.66	18.89	99.63	16.03	99.88	320.54	99.86	9,822.8	93.38	52.17	76.08	90.51	100.17
19	Baseline 11 Beta 9780	34.32	104.51	18.90	99.68	15.85	98.75	317.10	98.79	10,768.6	102.37	69.87	101.90	89.51	99.06
20	Hilleshog 2379	33.33	101.49	18.72	98.73	15.97	99.50	319.50	99.53	10,615.3	100.92	75.59	110.24	90.55	100.21
21	Filler #1	31.54	96.04	20.01	105.54	16.89	105.23	337.89	105.26	10,755.2	102.25	72.33	105.48	90.41	100.06
22	Beta 9284	33.30	101.40	19.98	105.38	17.08	106.42	341.55	106.40	11,261.9	107.06	66.44	96.89	90.66	100.33
23	Filler #2	27.77	84.56	19.99	105.43	17.08	106.42	341.62	106.42	9,591.7	91.19	79.25	115.58	90.69	100.37
24	Crystal M977	34.94	106.39	18.24	96.20	15.52	96.70	310.45	96.71	10,862.4	103.26	62.04	90.48	90.72	100.40
25	Crystal M002	32.01	97.47	19.11	100.79	16.23	101.12	324.52	101.10	10,843.0	103.08	74.30	108.36	90.73	100.41
26	Beta 9258	35.15	107.03	19.00	100.21	16.07	100.12	321.45	100.14	11,344.5	107.85	68.38	99.72	90.64	100.31
27	Crystal M223	32.68	99.51	18.95	99.95	15.93	99.25	318.61	99.26	10,292.7	97.85	70.94	103.46	89.85	99.44
28	SV 883	32.72	99.63	18.04	95.15	15.23	94.89	304.60	94.89	9,933.4	94.43	65.68	95.79	90.35	99.99
29	Hilleshog 2395	30.35	92.42	19.34	102.00	16.23	101.12	324.69	101.15	9,827.7	93.43	67.72	98.76	90.06	99.67
30	Beta 9291	32.22	98.11	18.80	99.16	15.92	99.19	318.47	99.21	10,521.3	100.02	72.08	105.12	90.56	100.22
31	Beta 9124	33.15	100.94	19.37	102.16	16.50	102.80	329.91	102.78	10,704.7	101.77	76.94	112.21	90.70	100.38
32	Beta 9986	34.41	104.78	17.53	92.46	14.75	91.90	295.04	91.91	10,597.3	100.75	72.78	106.14	90.11	99.72
33	Hilleshog 2448	28.71	87.42	19.60	103.38	16.54	103.05	330.78	103.05	9,704.3	92.26	59.99	87.49	90.13	99.75
34	Beta 9098	34.49	105.02	18.94	99.89	16.12	100.44	322.33	100.41	10,351.9	98.41	72.83	106.21	90.46	100.11
35	Crystal M089	36.81	112.09	18.27	96.36	15.35	95.64	306.92	95.61	11,266.7	107.11	79.26	115.59	89.72	99.29
36	Crystal M028	31.53	96.01	19.48	102.74	16.39	102.12	327.89	102.15	10,371.1	98.60	74.02	107.95	90.24	99.87
37	Hilleshog 2449	34.85	106.12	19.29	101.74	16.50	102.80	330.01	102.81	10,926.9	103.88	65.03	94.84	90.93	100.63
38	Crystal M106	32.15	97.90	19.31	101.85	16.55	103.12	331.05	103.13	10,627.8	101.04	67.52	98.47	91.06	100.77
39	Beta 9207	29.81	90.77	19.90	104.96	17.01	105.98	340.19	105.98	10,350.4	98.40	72.11	105.16	90.54	100.20
40	Hilleshog 2327	33.26	101.28	18.72	98.73	15.74	98.07	314.89	98.10	10,473.3	99.57	63.15	92.10	90.01	99.61
41	SV RR862	31.73	96.62	18.16	95.78	15.37	95.76	307.49	95.79	9,824.3	93.40	68.62	100.07	90.62	100.29
42	Crystal M260	31.60	96.22	19.29	101.74	16.29	101.50	325.86	101.51	10,418.3	99.04	67.56	98.53	90.26	99.89
	GRAND MEAN	32.84		18.96		16.05		321.00		10,518.9		68.57		90.36	
	Residual	5.07		0.40		0.47		189.86		577,675.08		44.89		0.91	
	%CV	7.36		3.61		4.59		4.59		7.48		10.25		1.05	
	LSD (0.05)	2.76		0.78		0.84		16.79		897.17		8.01		1.09	

Date of Harvest Trials

Neil Olson[1] and **Cody Groen**[2]

[1]Production Agronomist, [2]Post-Harvest Storage Agronomist, SMBSC, Renville, MN

Sugar beets are a biennial crop and will continue to increase in yield and sugar content during the first year of growth until the beets are harvested. This rate of growth and sugar accumulation can vary based on the environmental conditions present in any given year and the health of the sugar beet foliage. Starting in 2011 SMBSC began to perform trials to measure the rate of growth of the sugar beets during the period from late July through mid-October.

Research Objective

- These trials provided rate of growth data for each season for sugar content, tons per acre (TPA), purity, and extractable sugar per acre (ESA). The weekly harvest information could also be used to look at the SMBSC prepile premium and how effectively it compensates shareholders for early harvesting a portion of their sugar beet crop.

Methodology

Trials were established at 2-4 locations across the Cooperative each season since 2011. These trials were often conducted on the same locations as the SMBSC Official Variety Trials. In 2022, the three Date of Harvest Trials were conducted at a location near Murdock, Lake Lillian, and Renville. Trial maintenance was performed similar to the nearby Official Variety Trial and followed Best Management Practices. Each week during the mid-August to early-October period approximately 180' of row was harvested from each trial location. Harvest was accomplished with a tractor mounted one-row defoliator and one-row sugar beet harvester. The beets harvested each week were placed in tare bags and brought to the SMBSC Tare Lab for weights and quality analysis. Sample analysis included tare, sugar content, and purity. Row lengths were measured each week prior to harvest and these lengths were used to calculate the area harvested. The calculated harvested area for each week was used to determine yield on a per acre basis.

Results

The first harvest date for the trial was August 3, 2022. Harvesting continued on a weekly basis until October 12, 2022. Harvest was conducted once a week. A total of eleven harvest timings were completed in 2022. Trials sites had even stands, uniform canopy development, minimal root rot at Murdock and Renville with Lake Lillian having moderate root rot. All sites had minimal CLS.

Table 1 shows the average pounds extractable sugar per acre (ESA) increase per day for each of the past twelve years, between mid-August to early-October. From 2011-2021, the daily average rate of increase in ESA was 82.58 pounds extractable sugar per day. The increase in ESA per day for 2022 of 91.32 pounds was greater than the long-term mean rate of gain. Although the 2022 rate of gain for ESA was lower than the 2021 record year, it was greater than the 2016-2020 years. Unlike the 2021 year, the 2022 high rate of gain in ESA was led by an abnormally high rate of gain in % sucrose. Growth rate across the season for ESA is illustrated in Figure 1.

Table 2 shows the average rate of gain for percent sugar concentration data. The long-term rate of increase on percent sugar is 0.06% per day and 0.39% per week. In 2022, sugar increased at a greater rate than the long-term average at 0.09% per day and approximately 0.65% per week. This is the highest daily rate increase since 2014 and the highest weekly rate increase since 2011. Figure 2 illustrates the data from 2022 for sugar percent rate of gain. The high rate of ESA gain was driven by this higher rate of % sucrose gain.

Table 3 shows the average rate of gain of TPA for the eleven-year period of 2011-2022. The long-term average is 0.22 TPA gained per day, and approximately 1.56 tons per week. The 2022 daily rate of gain for TPA was 0.24 TPA and the weekly rate of gain was 1.68 TPA. Although these rates are slightly higher than the long-term average, the 2022 rate of gain on TPA was much less than the 2021 record year. Figure 3 illustrates the data collected in 2022.

One of the purposes of the Date of Harvest Trials is to provide data on how well the prepile premium compensates SMBSC producers for their early-harvest deliveries. The prepile premium was instituted at SMBSC to pay an additional premium on early-harvested tons so that they are paid at comparable rates as tons harvested on the first day of main harvest. For 2022, prepile began for SMBSC producers on 9/19/2022 and ended 12 days later on 9/30/2022, with main harvest beginning 10/01/2022.

Data from the 2022 Date of Harvest Trial is found in Table 4. Because the trial had harvest dates earlier than the start of producer's prepile harvest, no calculated estimates are provided for the dates prior to 9/19/2022. These revenue values are left blank because the start date of prepile and the gain there-after influence the daily premium calculation. The 2022 prepile daily premium wasn't designed to compensate for the lower yield and quality of beets harvested prior to 9/19/2022. Although an estimate could be provided by stepping the daily premium back to those dates in question, this would make an assumption that would result in an imperfect estimate. The nature of the prepile premium is to change as the prepile period, the rate of gain, and the final beet payment change. Starting the cooperative prepile period three weeks earlier may result in a different daily premium. Calculating a new daily premium would involve speculation on multiple factors. The simpler method (with least speculation) is to leave these dates out of the estimate, rather than risk false speculation.

Table 4 can be used to track yield and sugar content for the early harvest dates shown in grey. Table 4 can also be used to compare yield, sugar content, and relative revenue for the non-gray portions of the table. Table 4 shares revenue values as percent of mean (PoM). This is done by treating the harvest date of 10/05/2022 (the nearest to main harvest that occurs at or after main harvest) as the "mean" and comparing this value to other dates. The nearer a value is to 100.00 the closer the value is the payment on day 1 of main harvest, as a value grows larger than 100, that revenue is more than the first day of main harvest. All of the dates of prepile saw revenues higher than the first day of main harvest. For data generated in the 2022 Date of Harvest Trial, revenue per acre averaged 23.4% greater for those acres where tons were delivered during prepile than at the beginning of main harvest.

It is important to point out that this trial compares "like for like", in that the harvested beets are designed to be as uniform as possible that represent the main part of a given field of sugar beet. This can be different than the prepile harvest that many producers conduct. A common use of prepile allocation at SMBSC is to remove headlands prior to the start of main harvest, which may have yield and quality that differs from the main part of a field. Additionally, if an SMBSC producer would like to calculate actual revenue values, they can do so utilizing the shareholder portal's "Prepile Rates" under "Financial Reports" and the "Revenue Calculator" under "Tools".

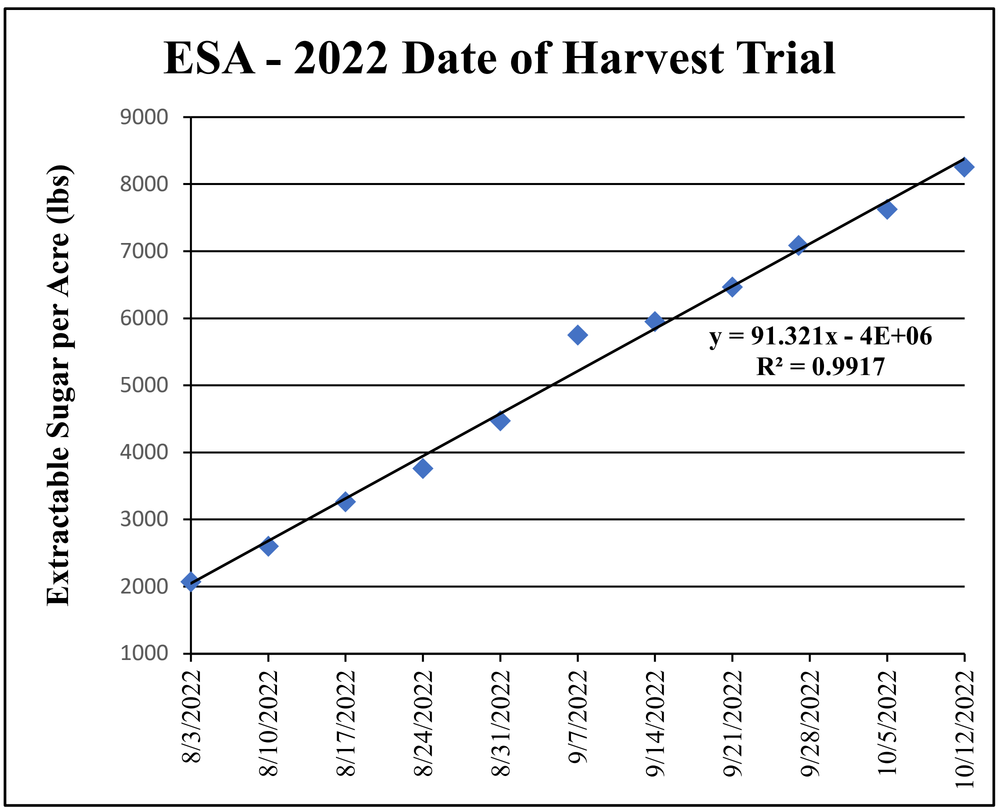

Figure 1. Extractable sugar per acre (ESA) data collected during the 2022 Date of Harvest trials, plotted across the harvest period, depicting a positive trend.

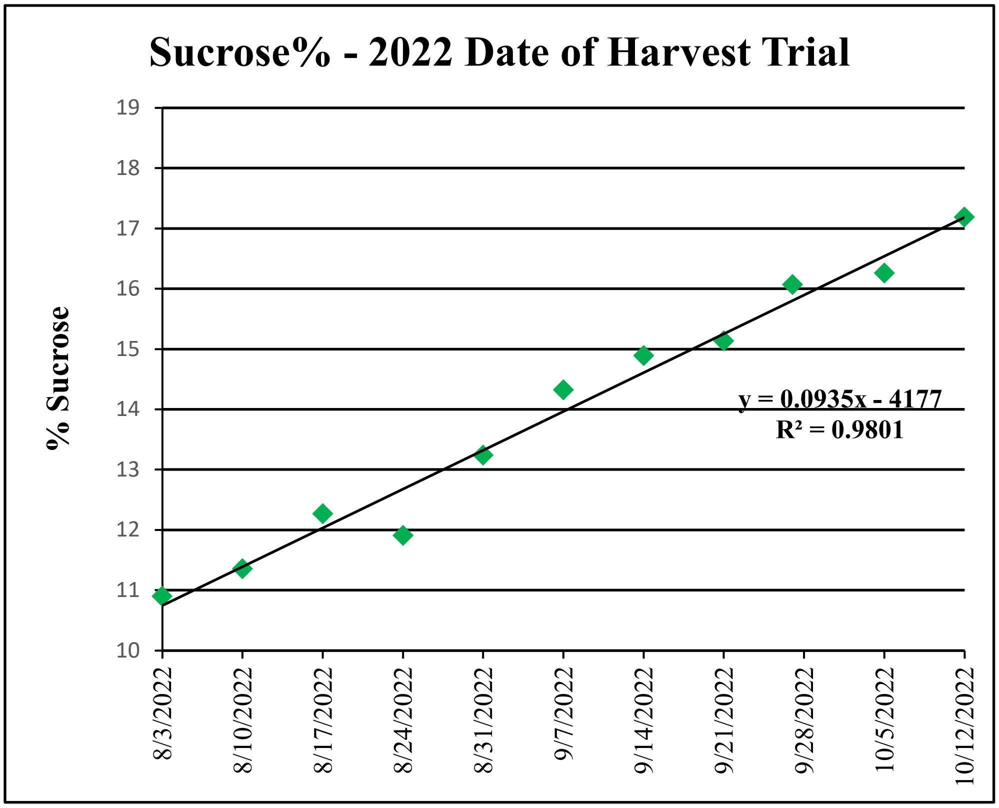

Figure 2. Sugar percent data collected during the 2022 Date of Harvest Trials, plotted across the harvest period, depicting a positive trend.

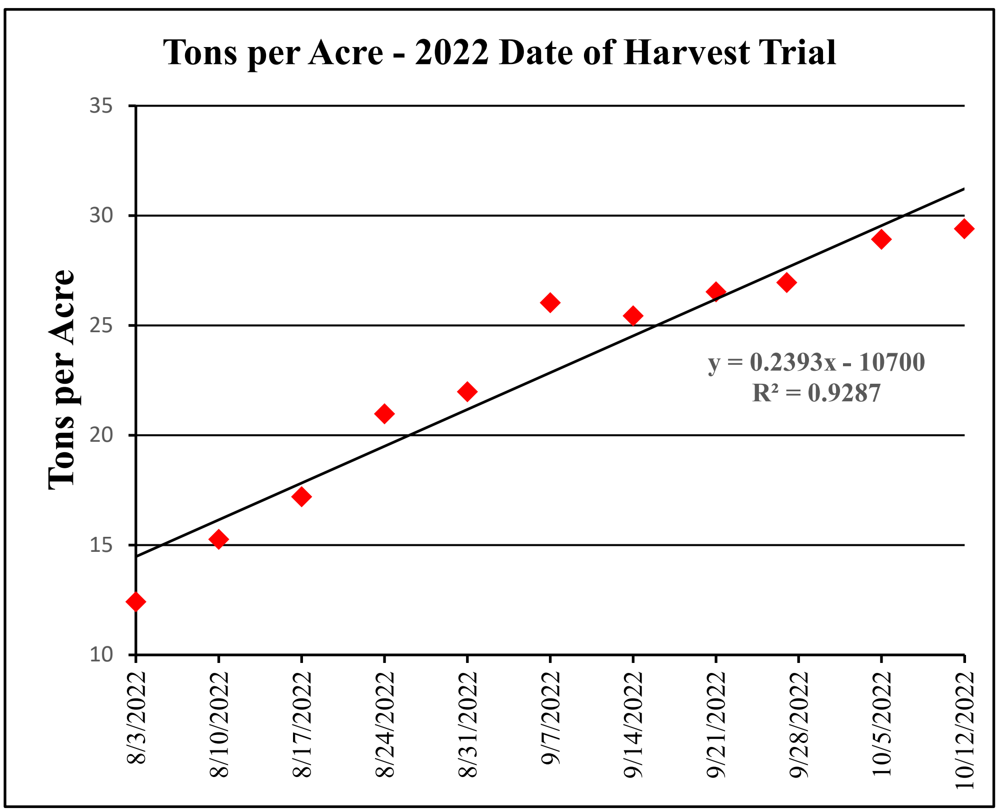

Figure 3. Tons per acre data collected during the 2022 Date of Harvest Trials, plotted across the harvest period, depicting a positive trend.

Table 1. 2011-2022 Regression Analysis of Extractable Sugar per Acre Increase per Day

Year	Extractable Sugar per Acre Increase per Day (lbs)
2011	100.7
2012	89.0
2013	91.6
2014	93.4
2015	99.8
2016	45.7
2017	60.0
2018	63.8
2019	78.6
2020	79.0
2021	106.8
Average (2011-2021)	82.58
2022	91.32

Table 2. 2011-2022 Regression Analysis of Percent Sugar Increase per Day

Year	Percent Sugar Increase per Day (%)	Percent Sugar Increase per Week (%)
2011	0.10	0.70
2012	0.09	0.63
2013	0.05	0.35
2014	0.09	0.63
2015	0.06	0.42
2016	0.03	0.21
2017	0.06	0.42
2018	0.005	0.04
2019	0.04	0.28
2020	0.07	0.49
2021	0.02	0.14
Average (2011-2021)	0.06	0.39
2022	0.09	0.65

Table 3. 2011-2022 Regression Analysis of Ton per Acre Increase per Day

Year	Ton per Acre Increase per Day (tons)	Ton per Acre Increase per Week (tons)
2011	0.25	1.74
2012	0.15	1.06
2013	0.29	2.01
2014	0.23	1.59
2015	0.24	1.67
2016	0.14	0.99
2017	0.12	0.82
2018	0.27	1.87
2019	0.24	1.66
2020	0.16	1.12
2021	0.37	2.61
Average (2011-2021)	0.22	1.56
2022	0.24	1.68

Table 4. 2022 Date of Harvest Data with Prepile Percent of Mean

Date	Sugar (%)	Purity (%)	Tons per Acre	ES (%)	EST (lbs)	ESA (lbs)	Revenue without Premium per Acre PoM	Total Payment per Acre with Premium PoM	Week	Date
8/3/2022	10.9	86.3	12.4	8.3	166.9	2069.7			N/A	8/3/2022
8/10/2022	11.4	85.2	15.2	8.6	171.1	2601.2			N/A	8/10/2022
8/17/2022	12.3	87.4	17.2	9.7	193.5	3265.2			N/A	8/17/2022
8/24/2022	11.9	85.3	21.0	9.0	180.7	3757.7			N/A	8/24/2022
8/31/2022	13.2	86.4	22.0	10.3	206.5	4468.8			N/A	8/31/2022
9/7/2022	14.3	86.0	26.0	11.1	222.9	5751.8			N/A	9/7/2022
9/14/2022	14.9	86.8	25.4	11.8	235.3	5948.4			N/A	9/14/2022
9/21/2022	15.1	88.3	26.5	12.3	245.2	6467.0	77.0	134.1	1	9/21/2022
9/27/2022	16.1	88.9	27.0	13.2	263.7	7087.8	89.4	112.7	2	9/27/2022
10/5/2022	16.3	88.1	28.9	13.2	263.7	7626.1	100.0	100.0	Main Harvest	10/5/2022
10/12/2022	17.2	88.6	29.4	14.1	282.0	8254.3	100.0	100.0	Main Harvest	10/12/2022

Conclusion

Crop Year 2022 had a noticeably higher than average rate of gain for ESA and % sucrose. Since the rate of gain for TPA was near the long-term average, the lower TPA values are due to a compressed growing season. A wetter than normal spring led to a later than ideal planting dates that was common issue across the Cooperative. Crop Year 2022 and Crop Year 2021 were both higher than the long-term average ESA rate of gain. However, the main contributing factor to ESA was % sucrose in 2022 and TPA in 2021. The 2022. Since the weeks of 2022 Date of Harvest that were during prepile are all greater than 100.00% PoM, and the 2022 Date of Harvest Data mirrors the Cooperative trend, the data generated in this trial supports the claim that the prepile premium program worked as designed. Which is to pay premiums on deliveries in the prepile period that are at, or above, the payments for deliveries on the first day of main harvest.

Cercospora Leaf Spot Fungicide Screening Trials

David Mettler[1] and **Mark Bloomquist**[2]
[1]Research Agronomist, [2]Research Director, SMBSC, Renville, MN

Cercospora leaf spot (CLS) is the most destructive foliar disease to impact sugar beet production in the SMBSC growing area. Without effective new fungicides, controlling the disease has become more difficult. Despite advancements in variety tolerance to CLS the key to control is still utilizing best management practices that include an appropriately timed fungicide program that incorporates multiple modes of action along with planting sugar beet varieties with higher levels of genetic tolerance to CLS.

Research Objective

- An effective fungicide program paired with genetic tolerance is necessary to grow a profitable crop. Trials need to be conducted to test the efficacy of individual fungicides and possible synergies between fungicide products.

Methodology

Two trials were conducted in 2022 as randomized complete block with four replications. The Fungicide Screening Trial was located near Renville and the Product Synergy Trial was located near Clara City, MN. These trials evaluated fungicides individually and in combinations to look at possible synergies. The Renville site was planted on May 24th using Crystal M977. Dual Magnum and Ethofumesate were applied preemergence and other standard practices were used post emergence to keep the site weed free. The site was inoculated with pulverized leaves from the previous year that were infected with CLS. The inoculum was spread evenly across the site with a Gandy Orbit-Air applicator on July 18th. Six fungicide applications were made in the Fungicide Screening Trial beginning July 21st and continuing on a ten to twelve-day spray interval. The Clara City site was planted on June 6th using Crystal M977. Dual Magnum was applied preemergence and other standard practices were used post emergence to keep the site weed free. The Clara City site was inoculated on July 21st using the same procedures as the Renville site. Four fungicide applications were made in the Product Synergy Trial beginning July 25th and continuing on a ten to twelve-day spray interval.

Applications were made using a custom-made tractor mounted sprayer traveling 3.2mph with a spray volume of 20gpa and 60psi, utilizing XR11002 spray nozzles (Photo 1). Each plot consisted of six rows that were 35ft in length. The sprayer used CO^2 as a propellant and was designed to apply the treatment to the center four rows, leaving rows one and six untreated. Plots were rated for foliar damage using the (1-9) KWS (Kleinwanzlebener Saatzucht) scale with one being disease free and nine being completely necrotic. The center two rows of each six-row plot were harvested on September 29th at the Renville site and on October 19th at the Clara City site using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS version 9.4.

Results

In the Fungicide Screening Trial there were significant differences in overall yield and in foliar disease ratings. The control, Microthiol Disperss alone, and Badge SC alone had significantly lower yield than many of the other treatments (Table 1). The control had the highest foliar disease rating, followed by Microthiol Disperss alone and Badge SC alone (Table 2). Manzate Prostick alone and Proline plus Badge SC were similar and had better disease control than the other protectant fungicides applied alone. Most of the tank mixed treatments had similar foliar disease ratings.

The results of the Product Synergy Trial were similar to the Fungicide Screening trial for the shared treatments. The control and the Microthiol Disperss alone treatments had a lower yield than most other treatments (Table 3). Those treatments also had the highest foliar disease ratings, followed by Manzate Prostick with a low rate of Microthiol Disperss, Manzate Prostick alone, and Proline alone (Table 4). Proline plus Manzate Prostick had the lowest foliar disease rating, which was similar to the Proline plus Manzate Prostick and Microthiol Disperss.

Photo 1. Tractor mounted sprayer used for fungicide applications.

Table 1. Yield parameter results for the Fungicide Screening Trial. Values with different letters are significantly different. Table 5 contains a full description of each treatment.

Entry	Entry Description	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	Control	17.0	24.6 d	14.3	285.9	7020.4 cd	90.3
2	Manzate Prostick	17.0	27.9 bc	14.0	280.6	7810.9 ab	89.2
3	Proline	16.5	28.5 ab	13.4	268.6	7665.6 abc	88.4
4	Proline+Manzate Prostick	16.4	28.9 ab	13.6	271.2	7833.1 ab	89.2
5	Proline+Microthiol Disperss	16.4	28.8 ab	13.4	267.0	7700.6 abc	88.1
6	Manzate Prostick+Microthiol Disperss	16.4	29.0 ab	13.3	266.6	7740.9 abc	88.1
7	Proline+Manzate Prostick+Microthiol Disperss	16.6	29.0 ab	13.5	270.6	7849.7 ab	88.4
8	Microthiol Disperss	16.5	25.6 d	13.5	270.2	6912.6 d	88.7
9	Minerva+Manzate Prostick	16.8	27.9 bc	13.9	277.4	7757.9 abc	89.0
10	Inspire XT+Manzate Prostick	16.9	28.4 ab	14.0	279.4	7943.7 a	89.1
11	Proline+Badge SC	16.7	28.7 ab	13.7	275.0	7916.2 a	89.1
12	Supertin+Manzate Prostick	16.6	28.3 ab	13.5	270.6	7664.2 abc	88.3
13	Provysol+Manzate Prostick	16.9	29.0 ab	13.9	278.4	7975.4 a	89.0
14	Badge SC	16.5	26.3 cd	13.5	270.4	7106.3 bcd	88.7
15	Lucento+Manzate Prostick	16.8	29.9 a	13.8	276.4	8250.1 a	89.0
	Mean	16.7	28.1	13.7	273.8	7687.1	88.8
	CV%	3.1	4.6	4.4	4.4	6.8	1.2
	Pr>F	0.7976	<.0001	0.6605	0.6605	0.0415	0.4915
	lsd (0.05)	ns	1.8	ns	ns	743.6	ns

Table 2. Foliar ratings for the Fungicide Screening Trial using the KWS (1-9) rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Table 5 contains a full description of each treatment.

Entry	Entry Description	1-Sep	8-Sep	20-Sep
1	Control	3.9 a	6.1 a	7.3 a
2	Manzate Prostick	1.3 d	1.8 e	3.3 cd
3	Proline	1.2 d	1.4 fg	2.2 efg
4	Proline+Manzate Prostick	1.1 d	1.3 g	1.5 h
5	Proline+Microthiol Disperss	1.2 d	1.4 fg	1.9 gh
6	Manzate Prostick+Microthiol Disperss	1.2 d	1.8 e	2.7 def
7	Proline+Manzate Prostick+Microthiol Disperss	1.1 d	1.3 g	1.5 h
8	Microthiol Disperss	2.5 b	5.0 b	6.3 b
9	Minerva+Manzate Prostick	1.2 d	1.3 g	2.3 efg
10	Inspire XT+Manzate Prostick	1.2 d	1.3 g	2.1 fgh
11	Proline+Badge SC	1.2 d	2.2 d	3.9 c
12	Supertin+Manzate Prostick	1.2 d	1.4 g	2.0 fgh
13	Provysol+Manzate Prostick	1.2 d	1.7 ef	2.8 de
14	Badge SC	2.2 c	4.6 c	5.8 b
15	Lucento+Manzate Prostick	1.2 d	1.4 g	1.9 gh
	Mean	1.5	2.2	3.1
	CV%	10.3	8.5	14.4
	Pr>F	<.0001	<.0001	<.0001
	lsd (0.05)	0.2	0.3	0.6

Table 3. Yield parameter results for the Product Synergy Trial. Values with different letters are significantly different. Table 6 contains a full description of each treatment.

Entry	Entry Description	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	Control	16.6	25.1 ef	13.7	274.2	6848.1 d	89.1
2	Manzate Prostick	16.8	27.2 def	13.7	273.2	7436.3 cd	88.1
3	Proline	17.9	31.2 ab	14.7	293.9	9119.0 a	88.8
4	Proline+Manzate Prostick	17.2	31.9 a	14.2	283.8	9150.3 a	89.2
5	Proline+Microthiol Disperss	17.4	28.6 bcd	14.2	283.6	8107.9 bc	88.3
6	Manzate Prostick+Microthiol Disperss (1oz)	17.2	29.5 abcd	14.1	282.8	8322.2 abc	89.1
7	Manzate Prostick+Microthiol Disperss (1lb)	17.3	27.9 cde	14.3	285.1	7942.4 bc	89.1
8	Proline+Manzate Prostick+Microthiol Disperss	16.9	30.7 abc	13.8	275.2	8443.9 ab	88.1
9	Microthiol Disperss	16.8	24.4 f	13.6	271.1	6614.2 d	87.8
	Mean	17.1	28.3	14.0	280.3	7931.4	88.6
	CV%	3.1	7.6	4.0	3.9	7.6	1.0
	Pr>F	0.0802	0.0011	0.1378	0.1298	<.0001	0.2598
	lsd(0.05)	ns	3.2	ns	ns	886.2	ns

Table 4. Foliar ratings for the Product Synergy Trial using the KWS (1-9) rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Table 6 contains a full description of each treatment.

Entry	Entry Description	8-Sep	20-Sep	30-Sep	14-Oct
1	Control	5.1 a	7.0 a	7.9 a	8.7 a
2	Manzate Prostick	1.4 c	2.3 cd	3.3 c	3.5 d
3	Proline	1.6 c	2.1 cd	2.7 d	3.5 d
4	Proline+Manzate Prostick	1.3 c	1.3 e	1.4 e	1.8 f
5	Proline+Microthiol Disperss	1.4 c	1.9 de	2.3 d	2.6 e
6	Manzate Prostick+Microthiol Disperss (1oz)	1.5 c	2.6 c	3.6 c	4.3 c
7	Manzate Prostick+Microthiol Disperss (1lb)	1.3 c	1.9 de	2.3 d	2.7 e
8	Proline+Manzate Prostick+Microthiol Disperss	1.3 c	1.4 e	1.7 e	1.9 f
9	Microthiol Disperss	4.1 b	5.8 b	7.1 b	8.1 b
	Mean	2.1	2.9	3.6	4.1
	CV%	12.6	15.2	9.9	9.2
	Pr>F	<.0001	<.0001	<.0001	<.0001
	lsd (0.05)	0.4	0.7	0.5	0.6

Conclusions

Despite a low infection year, significant differences still occurred in yield and foliar disease ratings in both trials. In general, treatments that contained only one product had a lower yield and higher foliar disease rating highlighting the importance of tank-mix partners. Manzate Prostick continued to outperform other protectant fungicides such as Badge SC and Microthiol Disperss. However, Badge SC and Microthiol Disperss did improve the foliar disease rating over the control showing some fungicidal activity against CLS. Microthiol Disperss improved control of CLS when tank-mixed with Proline or Manzate Prostick, however it may not be a large enough improvement to warrant the extra cost of adding it to the tank. As in previous years, the tank-mix of Manzate Prostick plus Proline continues to perform very well. In the Fungicide Screening trial most of the triazole products combined with Manzate Prostick had very similar foliar disease ratings.

Table 5: Fungicide Screening Trial treatment list.

Entry	Entry Description	Rate/A
1	Untreated	n/a
2	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
3	Proline	5.7 oz
	Masterlock	6.4 oz
4	Proline	5.7 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
5	Proline	5.7 oz
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
6	Manzate Prostick	2 lbs
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
7	Proline	5.7 oz
	Manzate Prostick	2 lbs
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
8	Microthiol Disperss	5 lbs
	Masterlock	6.4 oz
9	Minerva	13 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
10	Inspire XT	7 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
11	Proline	5.7 oz
	Badge SC	2 pints
	Masterlock	6.4 oz
12	SuperTin	8 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
13	Provysol	4 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
14	Badge SC	2 pints
	Masterlock	6.4 oz
15	Lucento	5.5 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz

Table 6: Product Synergy Trial treatment list.

Entry	Entry Description	Rate/A
1	Untreated	n/a
2	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
3	Proline	5.7 oz
	Masterlock	6.4 oz
4	Proline	5.7 oz
	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
5	Proline	5.7 oz
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
6	Manzate Prostick	2 lbs
	Microthiol Disperss	1 oz
	Masterlock	6.4 oz
7	Manzate Prostick	2 lbs
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
8	Proline	5.7 oz
	Manzate Prostick	2 lbs
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
9	Microthiol Disperss	5 lbs
	Masterlock	6.4 oz

Cercospora Leaf Spot Program Trials

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Cercospora leaf spot (CLS) is the most destructive foliar disease to impact sugar beet production in the SMBSC growing area. Without effective new fungicides, controlling the disease has become more difficult. Despite advancements in variety tolerance to CLS the key to control is still utilizing best management practices that include an appropriately timed fungicide program that incorporates multiple modes of action along with planting sugar beet varieties with higher levels of genetic tolerance to CLS.

Research Objective

- High levels of cercospora inoculum and a favorable environment for the development of CLS have been major contributors in causing losses to profitability in sugar beet production in recent years. An effective fungicide program paired with genetic tolerance is necessary to grow a profitable crop. Trials need to be conducted to test the efficacy of individual fungicides and season long fungicide programs.

Methodology

Two trials were conducted in 2022 as randomized complete block with four replications. The CLS Program Trial was located near Renville and the Variety Tolerance Trial was located near Clara City, MN. These trials evaluated fungicides in a program setting. The Renville site was planted on May 24th using Crystal M977 for the traditional CLS tolerant variety and Crystal M089 for the high CLS tolerant (HCT) variety. Dual Magnum and Ethofumesate were applied preemergence and other standard practices were used post emergence to keep the site weed free. The site was inoculated with pulverized leaves from the previous year that were infected with CLS. The inoculum was spread evenly across the site with a Gandy Orbit-Air applicator on July 18th. Seven fungicide applications were made in the Program Trial beginning July 14th and continuing on a ten to twelve-day spray interval. The Clara City site was planted on June 6th using Crystal M977 and M089. Dual Magnum was applied preemergence and other standard practices were used post emergence used to keep the site weed free. The Clara City site was inoculated on July 21st using the same procedures as the Renville site. Five fungicide applications were made in the Variety Tolerance Trial beginning July 18th and continuing on a ten to twelve-day spray interval.

Applications were made using a custom-made tractor mounted sprayer traveling 3.2mph with a spray volume of 20gpa and 60psi, utilizing XR11002 spray nozzles (Photo 1). Each plot consisted of six rows that were 35ft in length. The sprayer used CO^2 as a propellant and was designed to apply the treatment to the center four rows, leaving rows one and six untreated. Plots were rated for foliar damage using the (1-9) KWS (Kleinwanzlebener Saatzucht) scale with one being disease free and nine being completely necrotic. The center two rows of each six-row plot were harvested on September 29th at the Renville site and on October 19th at the Clara City site using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS version 9.4.

Results

Yield differences in both trials were minimal with significant differences occurring between the controls compared to most other treatments (Tables 1 and 3). The foliar disease ratings in the Program Trial were highest in the control treatments followed by the HCT varieties that received fewer sprays or only protectant fungicides (Table 2). No differences were observed between HCT treatments that had 4 or more fungicide applications. In the Variety Tolerance Trial the controls again had the highest foliar disease ratings. However, there were very little differences between most other treatments.

Photo 1. Tractor mounted sprayer applying a fungicide treatment on August 11th, 2022.

Table 1. Yield parameter results for the CLS Program Trial. Values with different letters are significantly different. Table 5 contains a full description of each treatment.

Entry	Variety	Entry Description	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	HCT	Control	15.3 cd	30.4 ef	12.2 cdef	244.9 cde	7428.2 cde	87.6
2	HCT	6 Spray Program	15.2 cde	33.4 a	12.2 cdef	243.3 cdef	8128.2 a	87.5
3	HCT	2 Spray Program	14.8 de	32.5 abcd	11.9 def	238.4 def	7739.3 abcd	88.1
4	HCT	4 Spray Tin Program	15.0 de	31.3 cdef	12.1 cdef	242.4 cdef	7569.2 bcd	88.2
5	HCT	4 Spray Triazole Program	14.9 de	31.8 bcde	11.9 def	238.1 def	7570.1 bcd	87.8
6	HCT	4 Spray EBDC Program	14.6 e	32.0 abcd	11.7 ef	232.9 ef	7433.1 cde	87.5
7	HCT	4 Spray Copper/EBDC	14.6 e	32.2 abcd	11.6 ef	232.3 ef	7464.1 cd	87.6
8	HCT	4 Spray Program	14.8 de	31.1 def	11.8 def	235.7 def	7334.2 def	87.5
9	Trad	Control	16.3 ab	25.1 gh	13.4 a	268.6 a	6754.9 g	88.9
10	Trad	6 Spray Program	15.4 cd	30.0 f	12.4 cd	247.5 cd	7396.4 cde	87.8
14	HCT	4 Spray Program	15.1 cde	32.9 ab	12.3 cde	245.6 cde	8079.9 ab	88.5
15	HCT	4 Spray Program	14.9 de	33.5 a	11.9 def	237.5 def	7946.5 abc	87.5
16	HCT	4 Spray Program	15.1 cde	32.5 abcd	12.2 cdef	242.9 cdef	7890.6 abc	87.9
17	HCT	4 Spray EBDC/Sulfur	15.7 bc	32.3 abcd	12.7 bc	254.1 bc	8197.4 a	87.9
18	HCT	4 Spray Program	15.1 cde	32.1 abcd	12.1 cdef	241.7 cdef	7765.6 abcd	87.4
19	HCT	2 Spray Program	14.6 e	32.8 abc	11.5 f	230.7 f	7562.2 bcd	87.2
		Mean	15.2	30.6	12.3	245.7	7518.3	87.9
		CV%	3.2	3.5	4.1	4.1	5.2	0.9
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.0516
		lsd(0.05)	0.7	1.5	0.7	14.1	552.0	ns

Table 2. Foliar ratings for the Program Trial using the KWS (1-9) rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Table 5 contains a full description of each treatment.

Entry	Variety	Entry Description	1-Sep	8-Sep	20-Sep	27-Sep
1	HCT	Control	1.4 c	2.8 c	3.9 c	4.4 b
2	HCT	6 Spray Program	1.1 d	1.2 e	1.3 g	1.6 h
3	HCT	2 Spray Program	1.1 d	1.3 de	1.8 efg	2.1 defg
4	HCT	4 Spray Tin Program	1.1 d	1.4 de	1.7 efg	2.0 defgh
5	HCT	4 Spray Triazole Program	1.1 d	1.3 de	1.7 efg	2.0 defgh
6	HCT	4 Spray EBDC Program	1.1 d	1.4 de	2.1 ef	2.2 def
7	HCT	4 Spray Copper/EBDC	1.2 cd	1.6 d	2.8 d	2.9 c
8	HCT	4 Spray Program	1.1 d	1.3 de	1.7 efg	2.0 defgh
9	Trad	Control	3.9 ab	5.9 b	7.8 ab	8.3 a
10	Trad	6 Spray Program	1.1 d	1.4 de	1.6 fg	1.9 efgh
14	HCT	4 Spray Program	1.2 cd	1.2 e	1.4 g	1.8 fgh
15	HCT	4 Spray Program	1.1 d	1.3 de	1.4 g	1.6 h
16	HCT	4 Spray Program	1.1 d	1.2 e	1.3 g	1.7 gh
17	HCT	4 Spray EBDC/Sulfur	1.1 d	1.4 de	1.4 g	2.0 defgh
18	HCT	4 Spray Program	1.1 d	1.3 de	1.6 fg	2.0 defgh
19	HCT	2 Spray Program	1.2 cd	1.3 de	2.2 de	2.4 cd
		Mean	1.7	2.3	3.0	3.4
		CV%	11.3	10.4	13.7	10.3
		Pr>F	<.0001	<.0001	<.0001	<.0001
		lsd (0.05)	0.3	0.3	0.6	0.5

Table 3. Yield parameter results for the Variety Tolerance Trial. Values with different letters are significantly different. Table 6 contains a full description of each treatment.

Entry	Variety	Entry Description	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	HCT	Control	16.1 bc	31.1 b	12.9 bc	257.5 bc	7986.9 a	87.2
2	HCT	5 Spray Program	15.8 bc	32.5 ab	12.7 c	253.1 c	8235.1 a	87.3
3	HCT	2 Spray Program	15.2 c	33.7 a	12.3 c	244.8 c	8239.7 a	88.0
4	HCT	3 Spray Tin Program	16.1 bc	32.4 ab	13.1 bc	262.4 bc	8488.0 a	88.4
5	HCT	3 Spray Triazole Program	15.7 c	31.3 ab	12.9 bc	257.6 bc	8069.2 a	88.8
6	HCT	3 Spray EBDC Program	16.0 bc	31.5 ab	13.0 bc	260.4 bc	8184.7 a	88.4
7	HCT	3 Spray EBDC/Copper	15.9 bc	32.0 ab	12.8 bc	255.7 bc	8166.8 a	87.7
8	HCT	3 Spray Program	15.9 bc	33.1 ab	12.8 bc	256.7 bc	8504.7 a	88.0
9	Trad	Control	16.8 b	23.9 c	13.8 b	275.6 b	6595.3 b	88.5
10	Trad	5 Spray Program	17.9 a	26.0 c	14.9 a	299.1 a	7787.4 a	89.8
		Mean	16.2	30.8	13.1	262.3	8025.8	88.2
		CV%	4.4	5.6	5.5	5.5	8.2	1.4
		Pr>F	0.002	<.0001	0.002	0.001	0.019	0.246
		lsd(0.05)	1.0	2.5	1.0	20.8	949.8	ns

Table 4. Foliar ratings for the Variety Tolerance Trial using the KWS (1-9) rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Table 6 contains a full description of each treatment.

Entry	Variety	Entry Description	8-Sep	20-Sep	30-Sep	14-Oct
1	HCT	Control	1.9 b	2.5 b	3.3 b	4.2 b
2	HCT	5 Spray Program	1.3 c	1.3 c	1.3 e	1.5 d
3	HCT	2 Spray Program	1.3 c	1.3 c	1.4 de	1.7 d
4	HCT	3 Spray Tin Program	1.3 c	1.3 c	1.4 de	1.7 d
5	HCT	3 Spray Triazole Program	1.4 c	1.3 c	1.5 de	1.8 d
6	HCT	3 Spray EBDC Program	1.3 c	1.4 c	1.6 cde	1.8 d
7	HCT	3 Spray EBDC/Copper	1.3 c	1.5 c	1.8 cd	2.3 c
8	HCT	3 Spray Program	1.4 c	1.3 c	1.4 de	1.7 d
9	Trad	Control	4.8 a	6.7 a	7.9 a	8.7 a
10	Trad	5 Spray Program	1.3 c	1.4 c	2.0 c	2.4 c
		Mean	1.7	2.0	2.4	2.8
		CV%	9.3	12.2	12.8	10.1
		Pr>F	<.0001	<.0001	<.0001	<.0001
		lsd(0.05)	0.2	0.4	0.4	0.4

Conclusions

The overall disease pressure in 2022 was low even though the trials were inoculated. As such, not many differences were observed, and few conclusions can be drawn from this data. However, the data for the high cercospora tolerant variety agrees with previous trials conducted by SMBSC. These highly tolerant varieties need a fungicide program to adequately control CLS. Based on previous trials and the current trials it would appear that 4 fungicide applications can provide sufficient protection for tolerant varieties.

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Table 5: Program Trial treatment list. The application code indicates when the product was applied in the six spray program treatments.

Entry	Variety	Entry Description		Rate/Acre		Application Code
1	HCT	Control	n/a	n/a		ABCDE
2	HCT	6 Spray Program	SuperTin	8	oz	BD
			Masterlock	6.4	oz	0ABCDE
			Minerva	13	oz	C
			Manzate Prostick	2	lbs	0ABCDE
			Proline	5.7	oz	A
			Provysol	4	oz	E
3	HCT	2 Spray Program	SuperTin	8	oz	C
			Masterlock	6.4	oz	AC
			Proline	5.7	oz	A
			Manzate Prostick	2	lbs	AC
4	HCT	4 Spray	SuperTin	8	oz	AE
		Tin Progam	Masterlock	6.4	oz	0ACE
			Badge SC	2	pints	C
			Manzate Prostick	2	lbs	0ACE
5	HCT	4 Spray	Proline	5.7	oz	A
		Triazole Program	Masterlock	6.4	oz	0ACE
			Badge SC	2	pints	C
			Provysol	4	oz	E
			Manzate Prostick	2	lbs	0ACE
6	HCT	4 Spray	Manzate Prostick	2	lbs	0ACE
		EBDC Program	Masterlock	6.4	oz	0ACE
7	HCT	4 Spray	Manzate Prostick	2	lbs	0ACE
		EBDC/Copper Program	Badge SC	2	pints	ACE
			Masterlock	6.4	oz	0ACE
8	HCT	4 Spray Program	Proline	5.7	oz	A
			Masterlock	6.4	oz	0ACE
			SuperTin	8	oz	C
			Provysol	4	oz	E
			Manzate Prostick	2	lbs	0ACE
9	Trad	Control	n/a	n/a		ABCDE
10	Trad	6 Spray Program	SuperTin	8	oz	BD
			Masterlock	6.4	oz	0ABCDE
			Minerva	13	oz	C
			Manzate Prostick	2	lbs	0ABCDE
			Proline	5.7	oz	A
			Provysol	4	oz	E
14	HCT	4 Spray Program	Proline	5.7	oz	A
			Masterlock	6.4	oz	0ACE
			SuperTin	8	oz	C
			Provysol	4	oz	E
			Priaxor	6.7	oz	C
			Manzate Prostick	2	lbs	0ACE
15	HCT	4 Spray Program	Revytek	13	oz	A
			Masterlock	6.4	oz	0ACE
			SuperTin	8	oz	C
			Proline	5.7	oz	E
			Priaxor	6.7	oz	E
			Manzate Prostick	2	lbs	0ACE
16	HCT	4 Spray Program	Proline	5.7	oz	A
			Masterlock	6.4	oz	0ACE
			SuperTin	8	oz	C
			Veltyma	8	oz	E
			Manzate Prostick	2	lbs	0ACE
17	HCT	4 Spray	Manzate Prostick	2	lbs	0ACE
		EBDC/Sulfur Program	Microthiol Disperss	2	lbs	0ACE
			Masterlock	6.4	oz	0ACE
18	HCT	4 Spray Program	Proline	5.7	oz	A
			SuperTin	8	oz	C
			Provysol	4	oz	E
			ADM-CS43	1	gal	0ACE
			Manzate Prostick	2	lbs	0ACE
19	HCT	2 Spray Program	SuperTin	8	oz	C
			Masterlock	6.4	oz	AC
			Proline	5.7	oz	A
			Manzate Prostick	2	lbs	AC
			Vacciplant	16	oz	0ACE

Table 6: Variety Tolerance Trial treatment list.

Entry	Variety	Entry Description		Rate/Acre	Application Code
1	HCT	Control	n/a	n/a	ABCD
2	HCT	5 Spray Program	SuperTin	8 oz	BD
			Masterlock	6.4 oz	0ABCD
			Minerva	13 oz	C
			Manzate Prostick	2 lbs	0ABCD
			Proline	5.7 oz	A
3	HCT	2 Spray Program	SuperTin	8 oz	C
			Masterlock	6.4 oz	AC
			Proline	5.7 oz	A
			Manzate Prostick	2 lbs	AC
4	HCT	3 Spray	SuperTin	8 oz	AC
		Tin Progam	Masterlock	6.4 oz	0AC
			Manzate Prostick	2 lbs	0AC
5	HCT	3 Spray	Proline	5.7 oz	A
		Triazole Program	Masterlock	6.4 oz	0AC
			Minerva	13 oz	C
			Manzate Prostick	2 lbs	0AC
6	HCT	3 Spray	Manzate Prostick	2 lbs	0AC
		EBDC Program	Masterlock	6.4 oz	0AC
7	HCT	3 Spray	Manzate Prostick	2 lbs	0AC
		EBDC/Copper	Badge SC	2 pints	AC
			Masterlock	6.4 oz	0AC
8	HCT	3 Spray Program	Proline	5.7 oz	A
			Masterlock	6.4 oz	0AC
			SuperTin	8 oz	C
			Manzate Prostick	2 lbs	0AC
9	Trad	Control	n/a	n/a	ABCD
10	Trad	5 Spray Program	SuperTin	8 oz	BD
			Masterlock	6.4 oz	0ABCD
			Minerva	13 oz	C
			Manzate Prostick	2 lbs	0ABCD
			Proline	5.7 oz	A

Management of New Cercospora Leaf Spot Tolerant Sugar Beet Varieties

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Cercospora leaf spot (CLS) is the most destructive foliar disease to impact sugar beet production in Southern Minnesota. With the loss of the several fungicide classes to resistance and the steady decline in effectiveness of currently used fungicides, controlling CLS is more challenging than ever. However, the recent introduction of sugar beet varieties more tolerant to CLS promises to reduce the burden and reliance on fungicides to protect sugar beet production from this devastating disease.

Research Objective

- Evaluate new Cercopora leaf spot (CLS) tolerant sugar beet varieties to determine the appropriate fungicide spray program.

Methodology

Four similar trials were conducted as randomized complete block with four replications at two sites in 2020 and two sites in 2021. In both years one site was located near Clara City, MN and the other was located near Hector, MN. These trials evaluated three varieties with differing levels of genetic tolerance to CLS (2.0, 3.0, and 4.0 on the Kleinwanzlebener Saatzucht (KWS) rating scale) across six fungicide programs for a total of 18 treatments per location. The variety ratings were based on data from the SMBSC Official Variety Trial CLS nursery. Standard production practices were used to keep the sites free from weeds and other diseases. The sites were inoculated with pulverized leaves from the previous year that were infected with CLS. The inoculum was spread evenly across each site with a Gandy Orbit-Air applicator. Each plot consisted of six rows that were 35 feet in length. Fungicide treatments were applied to the center four rows using a custom-made tractor mounted hooded sprayer utilizing CO2 as a propellant (Photo 1). Rows one and six were left untreated as visual checks between plots (Photo 2).

The fungicide treatments were applied with a spray volume of 20 gpa and 60 psi, utilizing XR11002 nozzles. The same deposition aid adjuvant was included in all treatment applications. Fungicide applications were made on a ten-to-twelve-day interval beginning after inoculation. Letters following the fungicide program description indicate the timing of the fungicide applications (Tables 2, 3, 4, and 5). Foliar disease ratings were made using the KWS (1-9) rating scale with 1 having very little disease and 9 having a high level of disease severity. Foliar ratings were taken by members of the SMBSC research staff every two weeks after visual symptoms appeared in the check plots.

Photo 1. Tractor mounted hooded sprayer used to apply fungicide treatments.

Photo 2. Drone image of 2020 Clara City site.

The foliar ratings presented in this report are the average of all raters with only the final date of ratings presented (Table 1). The center two rows of each six-row plot were harvested. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for quality analysis at the SMBSC tare lab. Only the extractable sugar per acre (ESA) data is presented in this report. The trials at the four sites were not identical so the data was not combined and thus is presented separately (Tables 2, 3, 4, and 5). The yield data was analyzed using SAS 9.4 Proc GLM and disease foliar rating data was analyzed using SAS 9.4 Proc Anova.

Table 1. Important dates for each of the four locations.

Location	Planting Date	Inoculation Date	First Fungicide Application	Final Foliar Rating Date	Harvest Date
Clara City 2020	April 27th	July 6th	July 9th	September 14th	September 25th
Hector 2020	May 5th	July 10th	July 16th	October 1st	October 9th
Clara City 2021	April 24th	June 28th	June 30th	September 15th	September 23rd
Hector 2021	April 29th	July 8th	July 12th	September 8th	September 10th

Results

In every location, the 3.0 variety had very similar results to the traditional 4.0 variety. As such, the data from the 3.0 variety (treatments 7 – 12) is not presented in this report. To keep this report concise only the data from the final foliar rating and extractable sugar per acre (ESA) are shown and discussed (Tables 2, 3, 4, and 5). Other data may be made available upon request.

The only treatment for the traditional variety (KWS = 4) that provided an acceptable level of disease control at every site was the standard six spray tank-mixed program. All other treatments for the traditional variety did not provide adequate control except for treatment 17 in the 2020 Clara City trial. That treatment consisted of six applications of Manzate Prostick without any tank-mix partners. This provided similar control to the standard tank-mix program, which may have been due to the limited rainfall that occurred at that site. This may have allowed the Manzate Prostick to provide protection from infection for a longer period of time since in normal conditions it is prone to washing off the leaves in moderate rainfall events.

The check for the tolerant variety (KWS = 2) still developed disease to the point of causing a significant yield loss in two of the trials. In every trial, the untreated check had a higher level of disease pressure than all other treatments with the tolerant variety. All the tolerant variety fungicide programs had better disease control than the standard six spray tank-mix program for the traditional variety. As the number of applications was reduced the disease severity generally increased. The disease severity also increased as the initiation date of the fungicide program was delayed or if a single mode of action was used instead of a tank-mixed application.

Conclusions

It was no surprise that the standard tank-mix fungicide program was the best treatment for the traditional variety. Unfortunately, even the standard six spray tank-mix fungicide program sometimes is not good enough to keep commercial fields at an acceptable level of CLS. The new tolerant varieties are seen as a way to reduce the reliance on fungicides to control CLS. However, our research indicates that these new varieties are not immune from the disease and do require a fungicide program to maintain adequate control. The great news is that the fungicide program required for these tolerant varieties is perhaps half of the fungicide applications required for the traditional varieties. In the event of poor weather conditions for making spray applications, the new tolerant varieties should provide growers with more flexibility to make applications without falling behind on controlling the disease. However, it appears that an early start and tank mixing modes of action are still important management practices in controlling CLS and keeping this genetic tool viable for long term use.

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Table 2. 2020 Clara City CLS rating and yield data.

Treatment #	Variety	Fungicide Program	KWS CLS Rating (1-9)	Extractable Sugar per Acre (lbs)
1	2	Check	6.7 d	8140.5 efg
2	2	3 Spray Tank-Mix Program (ACE)	2.0 j	10373.5 ab
3	2	6 Spray Tank-Mix Program (ABCDEF)	1.7 j	11007.5 a
4	2	3 Spray No Tank-Mix (ACE)	2.9 i	9842.8 bcd
5	2	6 Spray No Tank-Mix (ABCDEF)	2.0 j	9378.0 cd
6	2	3 Spray No Tank-Mix (CDE)	4.0 h	9872.0 bc
13	4	Check	9.0 a	6493.8 ij
14	4	3 Spray Tank-Mix Program (ACE)	7.1 cd	9879.5 bc
15	4	6 Spray Tank-Mix Program (ABCDEF)	6.1 e	9881.5 bc
16	4	3 Spray No Tank-Mix (ACE)	8.3 b	8221.5 ef
17	4	6 Spray No Tank-Mix (ABCDEF)	6.6 de	9712.0 bcd
18	4	3 Spray No Tank-Mix (CDE)	9.0 a	7171.3 hi
		Mean	5.7	8759.4
		CV%	6.6	7.7
		Pr>F	<.0001	<.0001
		lsd (0.05)	0.53	951.0

Table 3. 2020 Hector CLS rating and yield data.

Treatment #	Variety	Fungicide Program	KWS CLS Rating (1-9)	Extractable Sugar per Acre (lbs)
1	2	Check	4.6 h	6557.0 bc
2	2	6 Spray Program (ABCDEF)	2.1 k	6831.3 ab
3	2	2 Spray Program (AC)	2.7 j	6877.8 ab
4	2	3 Spray Program (ABC)	2.4 jk	7343.5 a
5	2	3 Spray Program (CDE)	1.5 l	7113.3 ab
6	2	2 Spray Program (CE)	2.7 j	6881.8 ab
13	4	Check	9.0 a	4302.5 g
14	4	6 Spray Program (ABCDEF)	6.2 f	6529.8 bc
15	4	2 Spray Program (AC)	8.5 ab	5891.3 cde
16	4	3 Spray Program (ABC)	7.7 cd	5931.8 cd
17	4	3 Spray Program (CDE)	7.3 de	5980.3 cd
18	4	2 Spray Program (CE)	8.7 a	5684.5 de
		Mean	5.6	6067.9
		CV%	6.6	7.9
		Pr>F	<.0001	<.0001
		lsd (0.05)	0.53	681.6

Table 4. 2021 Clara City CLS rating and yield data.

Treatment #	Variety	Fungicide Program	KWS CLS Rating (1-9)	Extractable Sugar per Acre (lbs)
1	2	Check	6.8 e	9026.1 c
2	2	6 Spray Program (ABCDEF)	1.2 j	10891.4 ab
3	2	2 Spray Program(AC)	3.1 gh	11230.6 a
4	2	3 Spray Program (ABC)	2.4 i	11345.9 a
5	2	3 Spray Program (CDE)	2.9 hi	10758.8 ab
6	2	2 Spray Program (CE)	3.9 f	10646.8 ab
13	4	Check	9.0 a	5967.0 g
14	4	6 Spray Program (ABCDEF)	3.6 fg	10822.6 ab
15	4	2 Spray Program(AC)	9.0 a	9003.1 c
16	4	3 Spray Program (ABC)	7.8 d	10174.4 b
17	4	3 Spray Program (CDE)	7.7 d	8413.0 cde
18	4	2 Spray Program (CE)	8.5 bc	7643.3 ef
		Mean	6.1	9032.9
		CV%	5.5	7.9
		Pr>F	<.0001	<.0001
		lsd (0.05)	0.47	1011.7

Table 5. 2021 Hector CLS rating and yield data.

Treatment #	Variety	Fungicide Program	KWS CLS Rating (1-9)	Extractable Sugar per Acre (lbs)
1	2	Check	5.5 e	7734.8 abc
2	2	5 Spray Program (0ABCDE)	1.5 k	7724.6 abcd
3	2	3 Spray Tin Program (0ACE)	2.2 ij	7455.5 bcde
4	2	3 Spray Triazole Program(0ACE)	2.5 i	7125.2 de
5	2	2 Spray Triazole Program (BD)	3.5 gh	7778.5 ab
6	2	EBDC Alone Program (0ABCDE)	1.9 jk	7646.7 bcd
13	4	Check	9.0 a	5736.7 hi
14	4	5 Spray Program (0ABCDE)	3.6 g	7780.6 ab
15	4	3 Spray Tin Program (0ACE)	6.4 cd	7291.4 bcde
16	4	3 Spray Triazole Program(0ACE)	6.5 c	7452.8 bcde
17	4	2 Spray Triazole Program (BD)	8.5 b	6439.0 fg
18	4	EBDC Alone Program (0ABCDE)	5.3 ef	8302.5 a
		Mean	5.2	7119.0
		CV%	6.4	6.0
		Pr>F	<.0001	<.0001
		lsd (0.05)	0.47	606.1

Sugar Enhancement Trial

David Mettler[1] and **Mark Bloomquist**[2]
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The sugar content and purity of a beet crop is a major factor in how efficiently the factory can operate and ultimately how profitable the sugar beet crop will be to the shareholders. The SMBSC growing area has struggled to increase the sugar content of the beet crop in recent years. The impact of finding a product that could substantially increase the sugar content of the beet crop would be a monumental achievement.

Research Objective

- Low sugar content has hindered the SMBSC beet payment in recent years. Several products currently available were tested in this trial to evaluate their ability to improve the sugar content of the crop.

Methodology

A trial was conducted near Clara City to screen products that may have the ability to improve sugar content. The trial was planted on June 6th using Crystal M089. Normal agronomic practices were used to keep the trial weed and disease free. This trial was designed as a randomized complete block with four replications and twelve treatments (Table 1). Applications were made using a custom-made tractor mounted sprayer traveling 2.1mph with a spray volume of 30gpa and 60psi, utilizing XR11002 spray nozzles. Each plot consisted of six rows that were 35ft in length. The sprayer used CO2 as a propellant and was designed to apply the treatment to the center four rows, leaving rows one and six untreated. The center two rows of each six-row plot were harvested for yield and quality analysis on September 30th using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and samples of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Results

Significant differences were observed between treatments in all yield parameters, except for extractable sugar per acre (Table 2). Treatments 2 and 3 had significantly lower quality parameters than the control treatment but had no impact on tons per acre. Treatments 4 – 7 and 12 were not any different than the control treatment for any parameters. Treatments 8 – 11 had significantly higher quality parameters than the control, however, these treatments generally had lower tons per acre than the control. Some visual differences were observed in the foliage of treatments 8 and 10 (Photo 1).

Table 1. Description of treatments in the Sugar Enhancement Trial.

Trt #	Product	Rate/Acre	Application Code
1	Control	n/a	n/a
2	Trinexapac-ethyl	64 oz	Sept. 1
3	Trinexapac-ethyl	64 oz	Aug 14 and Sept. 1
4	Terramar	1 gal	July 15 and Sept. 1
5	FP-20	1 gal	15-Jul
	Sure K	1 gal	15-Jul
6	FP-20	1 gal	15-Jul
	Sure K	1 gal	15-Jul
	FertiRain	1 gal	15-Jul
7	K-Express	3 pints	Sept. 1
8	Proprietary product	142.2 oz	Aug 14 and Sept 1
9	Proprietary product	284.4 oz	Sept. 1
10	Proprietary product	71.1 oz	Aug. 14
11	Proprietary product	71.1 oz	Sept. 1
12	Proprietary product	71.1 oz	Sept. 14

Table 2. Yield parameter results for the Sugar Enhancement Trial.

Treatment	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	14.0 d	29.9 abc	10.8 e	215.1 e	6423.7	85.6 d
2	12.3 e	30.2 abc	9.2 f	184.3 f	5580.9	84.7 e
3	12.6 e	32.5 a	9.4 f	188.1 f	6114.3	84.1 e
4	13.8 d	30.2 abc	10.7 e	213.0 e	6425.5	85.8 d
5	14.1 d	29.6 abc	10.8 e	216.5 e	6297.1	85.5 d
6	14.0 d	30.6 ab	10.9 e	217.5 e	6649.6	86.0 bcd
7	14.0 d	29.0 bcd	10.9 e	217.3 e	6298.2	85.8 cd
8	16.2 a	21.8 f	12.9 a	257.2 a	5588.7	86.8 a
9	15.4 b	25.2 e	12.1 b	242.0 b	5922.7	86.5 ab
10	15.0 bc	27.2 cde	11.7 bc	234.9 bc	6376.4	86.4 abc
11	14.7 c	26.2 de	11.4 cd	228.6 cd	5980.3	85.9 cd
12	14.2 d	30.0 abc	11.0 de	220.4 de	6469.0	86.1 bcd
Mean	14.2	28.5	11.0	219.6	6173.7	85.8
CV%	2.0	7.8	2.7	2.6	8.3	0.5
Pr>F	<.0001	<.0001	<.0001	<.0001	0.1154	<.0001
lsd(0.05)	0.4	3.2	0.4	8.4	ns	0.6

Conclusions

Many foliar nutrient products have been tested in the past to improve the sugar content of sugar beets here at SMBSC and in other sugar beet production areas. None of these foliar nutrient products have been able to meaningfully increase sugar content with any consistency. Treatments 4 – 7 would fall into that category. Other products known as plant growth regulators have also been tested on sugar beets. These products have generally resulted in a negative impact on yield or quality; similar to treatments 2 and 3. However, in one year of data it appears that a proprietary product (treatments 8 – 12) has shown a positive impact on the quality. Unfortunately, it appears that this product may also have a negative impact on tons. Further work will be done with this product to evaluate its effectiveness on improving sugar content while maintaining tons per acre.

Photo 1. Drone image of Sugar Enhancement Trial taken September 28th. Plot picture of treatment 8 taken on September 20th.

Crop Rotation Trial

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Nitrogen management is a priority for production of high-quality sugar beets. Previous crop can affect nitrogen availability and earlier harvested crops like sweet corn and wheat tend to have less residue potentially leading to better planting conditions for the following beet crop.

Research Objective

- Provide previous crop and nitrogen fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

Methodology

A two-year trial was conducted as a 3 x 4 factorial with four replications north of Bird Island, MN. In the first year of the trial four rotational crops were planted in randomized blocks: field corn, soybean, sweet corn, and spring wheat. Soil samples were taken in the spring prior to planting the four rotational crops (Table 1) and fertilizer applications were made using University of Minnesota recommendations. The fertilizer treatments were applied broadcast in the spring and incorporated using a small field cultivator. Standard practices were used to keep the four rotational crops weed and disease free. Important dates and average yields are reported in Table 2. The previous crops were machine harvested with small research combines except for the sweet corn (Photo 1). The sweet corn was hand harvested and then mowed to chop up the stalks. The 2021 crop year was abnormally dry, especially in the area where this trial was located (Photo 2). As a result, the yields were somewhat suppressed, most notable the field corn.

The rotational crop blocks were soil sampled to a depth of four feet in the fall of 2021. For the second year of the trial sugar beets were planted into each of the rotational crops. Prior to planting, the blocks were separated into 3 treatments for each crop. These treatments were residual nitrogen only, 110 lbs total N, and 150 lbs total N (Table 3). Nitrogen treatments were applied as urea and incorporated with a small field cultivator. The site was planted on May 23rd using Crystal M089. Standard grower practices were used to keep the site weed and disease free. The center two rows of each six-row plot were harvested on September 20th using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Table 1. Soil test results for Bird Island location from spring soil sample in 2021.

Soil test	Bird Island
Soil nitrate-N 0-2 ft. (lb N/A)	32
Olsen P 0-6 in. (ppm)	8.5
K 0-6 in. (ppm)	308
pH 0-6 in. (unitless)	7.6
Organic matter 0-6 in. (%)	5.2

Table 2. Planting date, harvest date, and yield for the four rotational crops in 2021.

Previous Crop	Planting Date	Harvest Date	Yield per Acre
Field Corn	May 6th	October 19th	140 bushels
Soybean	May 7th	October 6th	55 bushels
Sweet Corn	May 6th	August 10th	9 tons
Spring Wheat	April 22nd	August 2nd	51 bushels

Photos 1 & 2. Combine used to harvest the spring wheat. Sweet corn in the dry summer conditions.

Table 3. The crop rotation trial had 12 treatments that were based upon previous crop and total N (Residual + Applied).

Treatment	1	2	3	4	5	6	7	8	9	10	11	12
Previous Crop	Field Corn	Field Corn	Field Corn	Soybean	Soybean	Soybean	Sweet Corn	Sweet Corn	Sweet Corn	Spring Wheat	Spring Wheat	Spring Wheat
Residual N (lbs)	42	42	42	47	47	47	76	76	76	11	11	11
Applied N (lbs)	0	68	108	0	63	103	0	34	74	0	99	139
Total N (lbs)	42	110	150	47	110	150	76	110	150	11	110	150

Results

The crop planted in the year prior to sugar beets had a significant impact on the sugar beet yield (Table 4). Sugar beets planted after sweet corn had a higher yield compared to following the other three crops tested in this trial. The sugar beets planted after spring wheat had a lower sugar content than beets following the other three crops. Nitrogen rate also had a significant impact on yield and quality (Table 5). As the nitrogen rate increased the quality of the sugar beets decreased. However, the tons per acre also increased as the nitrogen rates increased. This increase in tons yielded a higher extractable sugar per acre than the residual N treatment even though the quality of the sugar beets decreased.

Table 4. The effect of previous crop on root yield and quality averaged across N rates.

Previous Crop	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Field Corn	14.7 a	35.9 b	12.2 a	244.3 a	8754.4 b	90.0 a
Soybean	14.8 a	35.1 b	12.2 a	243.8 a	8555.6 b	89.7 ab
Sweet Corn	14.8 a	38.5 a	12.2 a	244.3 a	9392.6 a	89.8 a
Spring Wheat	14.3 b	36.0 b	11.7 b	233.4 b	8373.2 b	89.1 b
Mean	14.6	36.4	12.1	241.4	8769.0	89.6
CV%	2.2	6.2	3.2	3.2	5.8	0.8
Pr>F	0.002	0.0059	0.0023	0.0023	0.0001	0.037
lsd(0.05)	0.3	1.9	0.3	6.3	421.2	0.6

Table 5. The effect of fertilizer N on root yield and quality averaged across previous crops.

N Rate	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	14.9 a	33.0 b	12.4 a	247.0 a	8143.8 b	90.0 a
110	14.7 a	38.0 a	12.1 a	242.0 a	9187.4 a	89.6 ab
150	14.4 b	38.1 a	11.8 b	235.4 b	8975.6 a	89.3 b
Mean	14.6	36.4	12.1	241.4	8769.0	89.6
CV%	2.2	6.2	3.2	3.2	5.8	0.8
Pr>F	0.0004	<.0001	0.0006	0.0006	<.0001	0.0229
lsd(0.05)	0.2	1.6	0.3	5.5	364.8	0.5

Conclusions

Yields in the SMBSC Agronomic Practice Database have indicated that canning crops such as sweet corn and peas have a positive impact on the following sugar beet crop. This could be due to the early harvest of the canning crops and lower crop residue levels. The early harvest gives the residue ample time to breakdown, which leads to less tie-up of nitrogen in the next year and potentially creates a good seed bed to plant sugar beets. Wheat also has the benefit of an early harvest, however, if the grain that is dropped during harvest is allowed to grow, like it was in this trial, then the following cover crop can also tie-up nitrogen and create a less ideal seed bed than if the cover crop was terminated earlier. Leaving the volunteer wheat to grow, followed by a dry spring had a negative impact on the sugar beet stand in the following year. Low residual nitrogen left in the soil following spring wheat resulted in a higher rate of applied nitrogen compared to the other crops. A low stand count and high rate of applied nitrogen could explain the low sugar content of the sugar beet plots following spring wheat. These are results from a single trial and should be utilized with that in mind. A second trial has been established with rotational crops planted in 2022 and will have sugar beets planted in 2023.

SMBSC. Southern Minnesota Agricultural Research

Soil Fertility for Corn Grown after Unharvested Sugar Beets

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Justification: The goal of SMBSC is to optimize the sugar factory's capacity. To do this the grower's goal is to raise enough high quality sugar beets to meet the needs of the factory. Some years this may mean sugar beet acres will not be harvested due to greater than anticipated yield and a limited slice capacity. Little information exists on management practices for optimum corn production following unharvested sugar beets.

Objective: Determine what management practices are useful for optimum field corn production following unharvested sugar beets. Specifically answering the following questions: 1. Do the unharvested roots need to be removed, 2. Does the use of starter fertilizer help corn production, and 3. Does the corn crop need more N applied after unharvested roots compared to removed roots?

Materials and Method: A study was conducted on corn grown in 2018, 2020, 2021, and 2022 to answer these objectives. The study was located near the SMBSC factory in Renville, MN in 2018, near the Murdock piling site in 2020, near Cosmos, MN in 2021, and near Maynard, MN in 2022. In 2017, 2019, 2020, and 2021, the sites were planted to sugar beets and the beets were defoliated but not harvested except for selective treatments. Field corn was grown in the following year. The study included the treatments listed in Table 1. The experimental design was a randomized complete block with four replications. All but three treatments had unharvested sugar beets left in the plot (Photo 1 and 2). Treatments 7, 8, and 9 had the sugar beet roots harvested. Nitrogen fertilizer rates were based on the soil test to 2 feet. Since the soil nitrate-N was low, the MRTN recommendation for corn/corn was used at a price ratio of 0.10 = 155 lb N/A. Seven gallons of 10-34-0 plus 1 lb zinc/A was used as an infurrow starter on all but treatments 1 and 8. In 2018, the site was hand harvested on October 30, the 2020 site was machine harvested on November 4, the 2021 site was hand harvested on September 30, and the 2022 site was hand harvested on October 12.

Table 1. Treatments for field corn following sugar beet production trial.

Treatment	Beets	Starter	N rate
1.	Not harvested	none	0
2.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0
3.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended – 40 lb N/A (115 lb N/A)
4.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)
5.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended + 40 lb N/A (195 lb N/A)
6.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended + 80 N/A (235 lb N/A)
7.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)
8.	Harvested	None	0
9.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0

Results:

2018: The corn yields were variable because of the very wet weather experienced in 2018. The statistics and corn yields are reported in Table 2 and 3. Even with the large variability, grain yields were significantly affected by the treatments. The corn grown where the sugar beet roots were harvested yielded 35 bu/acre greater than the corn grown where the beet roots were not harvested, Table 3. Additional N fertilizer was needed for corn for better grain yields. The increase in grain yield was 102 bu/acre when the check was compared to the recommended N rate. Additional N was also needed for corn grown where the beet roots were not harvested. The corn grown after the not harvested sugar beet responded to an additional 80 lb N/acre above the recommended N amount. The use of starter did not have a positive effect on corn grain yield. The wet conditions in 2018 were historical.

2020: The corn yields were good because of the ideal weather experienced in 2020. The statistics and corn yields are reported in Tables 2 and 3. Grain yields were significantly affected by the treatments. There was a significant increase in corn yield of 31 bu/acre if the sugar beets were harvested. The difference in corn yield of 14 bu/acre with the use of starter (7 gallons 10-34-0 plus 1 lb Zn/acre) was significant at the P>0.07 level. The use of N fertilizer at the recommended rate significantly increased corn grain yields by 100 bu/acre over the check. The use of additional 40 lb N/acre fertilizer above the recommended rate increased grain yield 21 bu/acre, significant for corn grown where sugar beets were not harvested the previous fall. Applying 80 lb N/acre above the recommended rate did not increase the corn grain yield above the extra 40 lb N/acre application. It took 40 lb N/acre above the recommended N rate for the corn grain yield on the not harvested treatment to be equal to the corn grain yield with recommended N application for the corn grown where the sugar beets were harvested the previous fall.

2021: The corn grain yields were poor because of drought conditions during the summer of 2021. The statistics and corn yields are reported in Tables 2 and 3. Grain yields were significantly affected by the treatments. There was a significant increase in corn yield of 34 bu/acre if sugar beets were harvested. The difference in corn yield of 7 bu/acre with the use of starter (7 gallons 10-34-0 plus 1 lb Zn/acre) was significant (P>0.09). The use of N fertilizer at the recommended rate significantly increased corn grain yields by 47 bu/acre. The use of an additional 40 lb N/acre fertilizer above the recommended increased grain yield 12 bu/acre, significant at the 0.05 probability for corn grown where sugar beet was not harvested the previous fall. Applying 80 lb N/acre above the recommended rate did not significantly increase the corn grain yield above the extra 40 lb N/acre application. In 2021, additional extra N to the not harvested treatment did not make it yield as well as the corn grown where sugar beet had been harvested the previous fall.

2022: The corn grain yields in 2022 were good but not extra ordinary, Tables 2 and 3. This was caused by wet planting conditions and dry conditions from August to harvest. The corn grain yields were significantly affected by treatments. Corn grain yields were 37 bu/acre greater if sugar beet roots were harvested. The use of starter increased corn grain yields 25 bu/acre and the use of N fertilizer where the sugar beet root was not harvested increased corn grain yield by 108 bu/A. The application of 40 lb N/acre greater did increase corn grain yield where the sugar beet roots were not harvest compared to the recommended N application. Increasing the rate to 80 lb N/acre did not increase the corn grain yield above the + 40 lb N/acre application. The use of additional N did not bring the corn grain yields equal to the corn grown where the sugar beet roots were harvest and had the recommended rate of N applied.

Table 2. Corn grain yield and statistical analysis for 2018, 2020, 2021, and 2022.

				Grain yield 15.5 % (bu/A)			
Treatment	Beets	Starter	N rate	2018	2020	2021	2022
1.	Not harvested	none	0	84	107	55	87
2.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0	69	126	61	103
3.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended – 40 lb N/A (115 lb N/A)	136	224	103	185
4.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)	173	234	112	223
5.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended + 40 lb N/A (195 lb N/A)	203	255	124	240
6.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended + 80 N/A (235 lb N/A)	242	241	129	232
7.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)	215	251	142	250
8.	Harvested	None	0	101	150	90	120
9.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0	115	160	99	154
$LSD_{0.05}$				47	21	12	17
Grand mean				149	196	102	176
Trt				0.0001	0.0001	0.0001	0.0001
Harvest vs No harvest				0.02	0.0001	0.0001	0.0001
Starter vs No starter				0.99	0.07	0.09	0.0005
0 N vs Recommended				0.0001	0.0001	0.0001	0.0001
C.V. %				21.6	7.2	8.3	6.7

Table 3. Corn grain yield means for direct comparisons of Not Harvested and Harvested sugar beet roots, use of starter fertilizer, and use of recommended N fertilizer in 2018, 2020, 2021, and 2022.

	Corn grain yield 15.5 % (bu/A)			
Comparison	2018	2020	2021	2022
Beets Not Harvested	109	156	76	138
Beets Harvested	144	187	110	175
No Starter	93	129	73	104
Starter	92	143	80	129
No N	92	143	80	129
Recommended N	194	243	127	237

Combined Analysis:

In the combined statistical analysis across all years, there was an interaction by treatment and year for corn grain yield. This interaction is because of magnitude of the grain yield response for the use of starter and the response of corn grain yield to N fertilizer application. The best way to show these responses is with graphs. In all years of this study, the corn grain yield on Not Harvested beet ground was less than corn grain yield on Harvested beet ground, Figure 1. This effect was similar in all years.

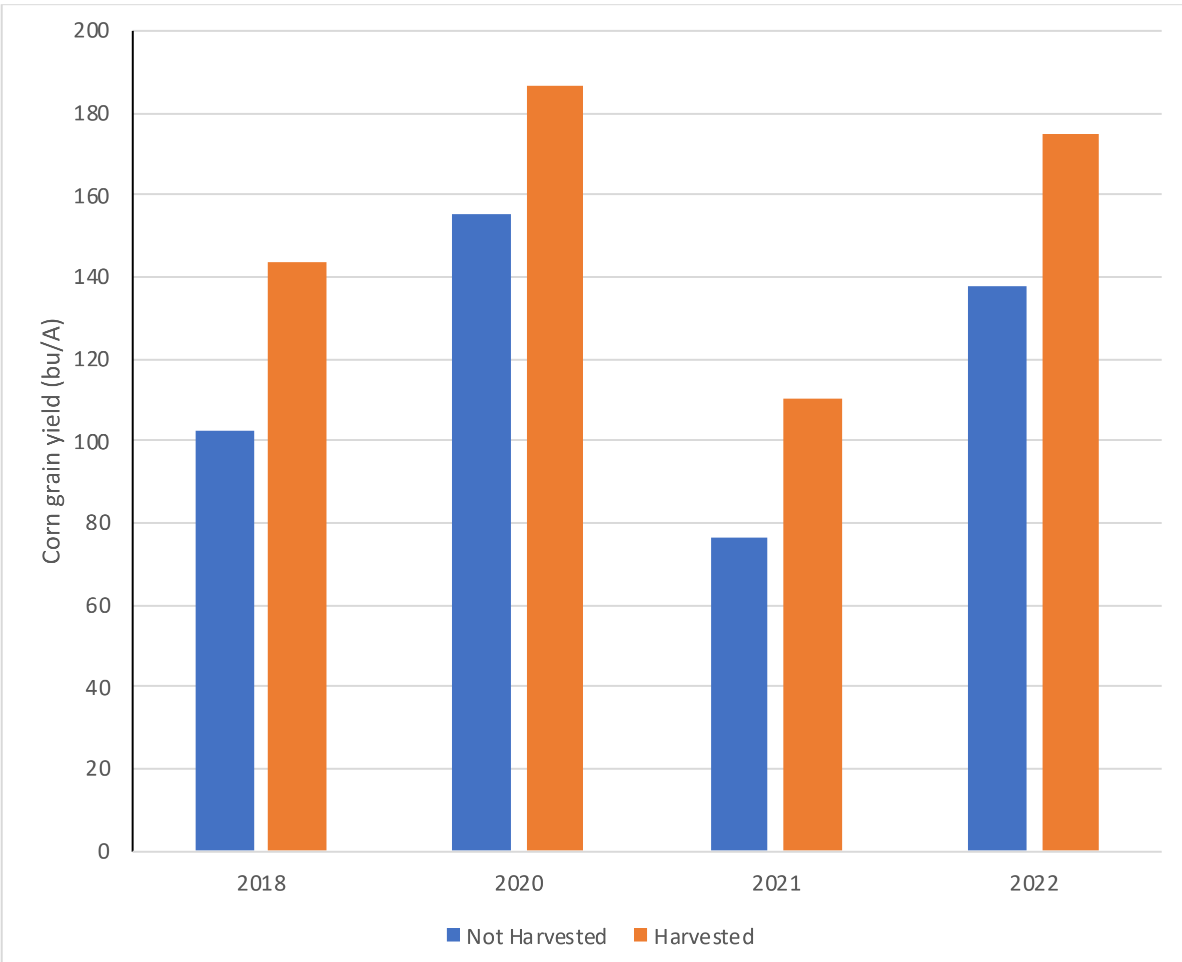

Figure 1. The effect on corn grain yield after sugar beet production with the sugar beet root not harvested or harvested in 2018, 2020, 2021 and 2022.

To make up for the loss in corn grain yield when grown on ground where the sugar beet was not harvested in the previous year, the use of starter fertilizer and additional N fertilizer were added. The use of starter did not significantly affect corn grain yield in 2018 but in 2020, 2021, and 2022 it was helpful, Figure 2.

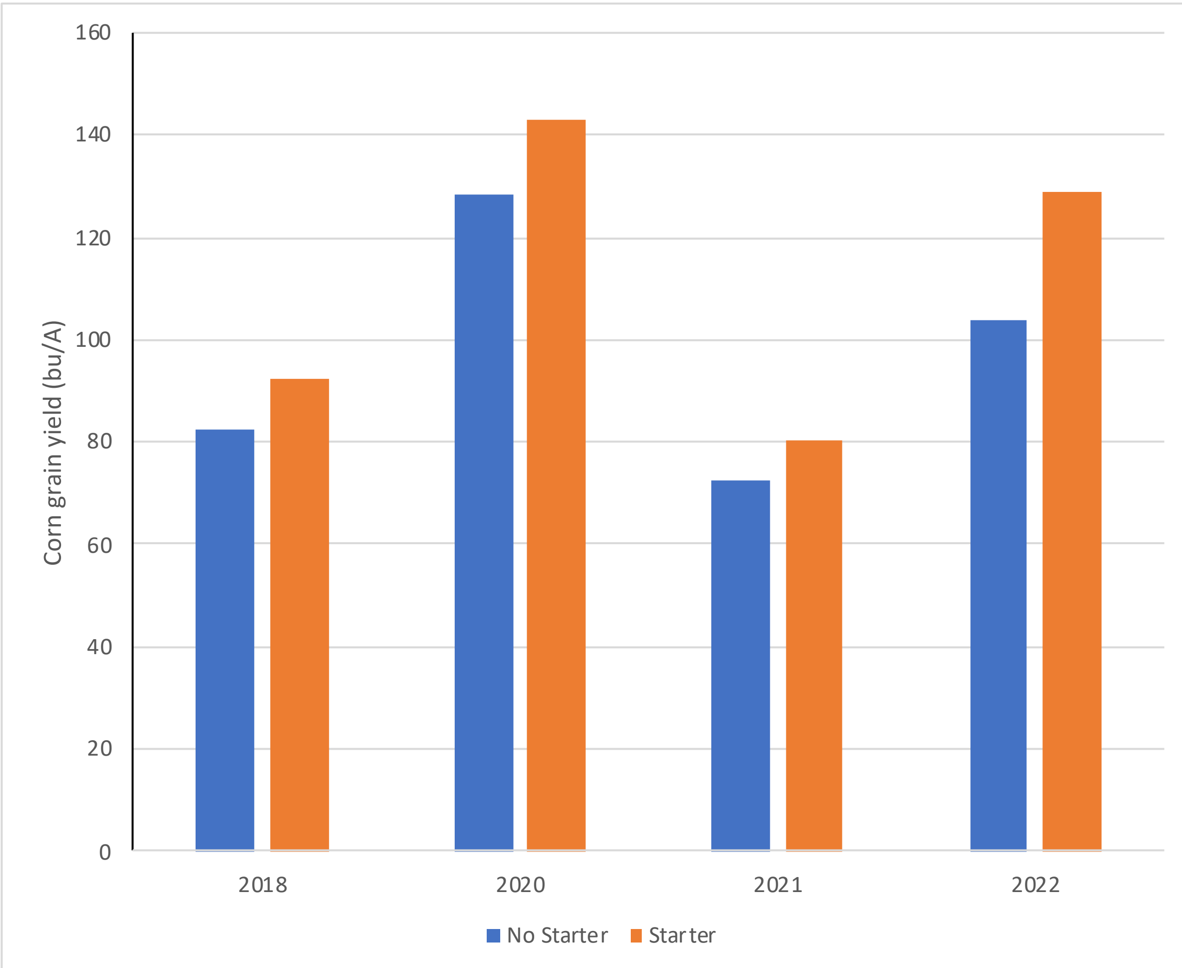

Figure 2. The effect of starter fertilizer (10-34-0 plus Zn) on corn grain yield grown on ground where the previous sugar beet roots were not harvested in 2018, 2020, 2021, and 2022.

In each year there was a corn grain yield response to N fertilizer, but the greatest grain yield occurred with N rec + 80 lb N/A in 2018, N rec + 40 lb N/A in 2020, 2021, and 2022, Figure 3. The corn yields in 2021 were reduced considerably because of drought and the grain yield responses were much smaller. The dark blue columns are the corn grain yields for corn grown on harvested beet plots with the recommended amount of N fertilizer applied. In 2018 and 2020 the corn grain yields from not harvested beet plots were similar to the harvested beet plots if at least an extra 40 lb N/A above the recommended N rate was applied.

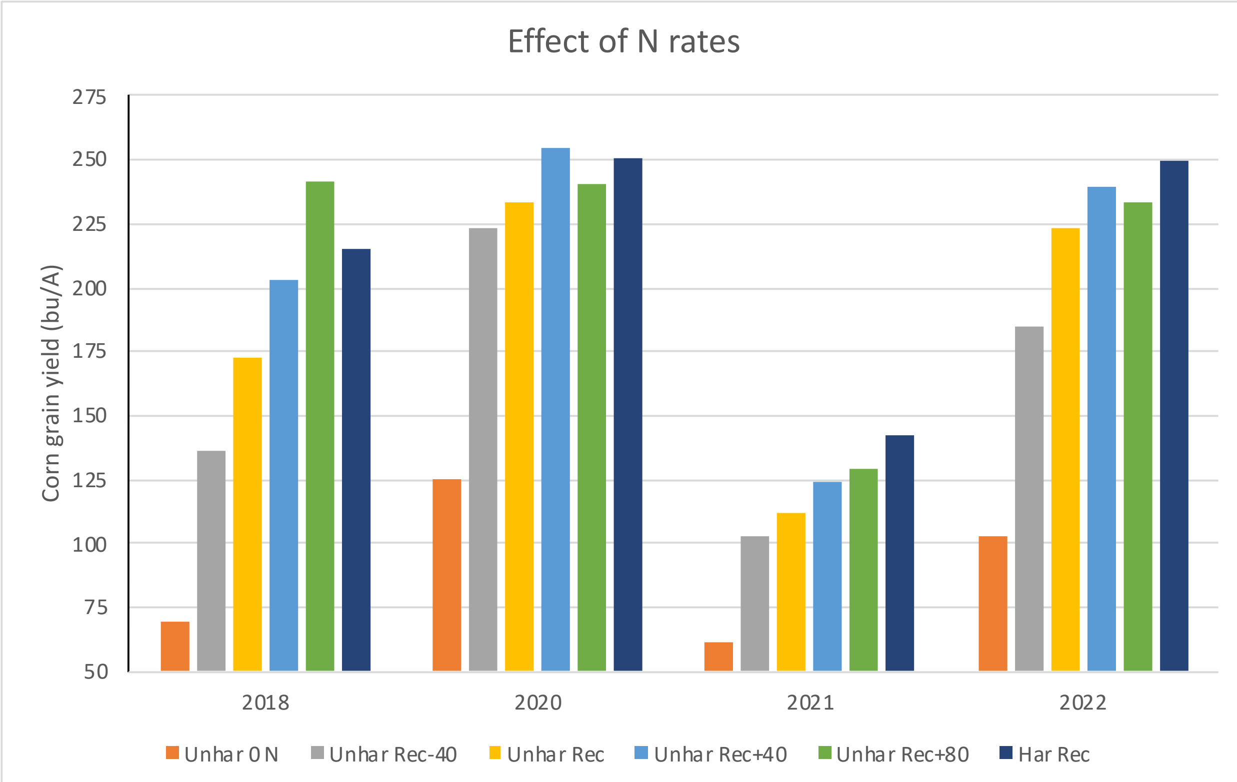

Figure 3. The effect on corn grain yield of added N fertilizer when grown on ground where the previous sugar beet roots were not harvested in 2018, 2020, 2021, and 2022.

Summary: This study was conducted in three very different climates. The climate was very wet in 2018, moisture was ideal for producing high corn grain yields in 2020, dry conditions reduced the corn grain yield in 2021, and planting was delayed by wet conditions while the fall was dry in 2022. Although every year was impacted differently by the environment there were always some visual differences between treatments including crop height and color (Photos 3 and 4). In all years, corn grown on not harvested sugar beet production ground had lower grain yields than corn grown on ground where the sugar beet root was harvested. In all production years, the use of 40 lb N/acre above the recommendation on not harvested sugar beet ground increased the corn grain yield. The use of 80 lb N/acre did not improve the grain yield over the treatment with an extra 40 lb N/acre. In 2020 and 2022, corn grain yields from an extra 40 lb N/acre applied to the ground where sugar beet was not harvested the previous fall was able to produce corn grain yields equal to the corn grown in harvested sugar beet ground. In 2021, the corn grain yields in the not harvested ground were not as good as the corn grain yields from the harvested ground. Why the difference? The extra N fertilizer was needed on the corn grown on the not harvested area because of the added carbon left in the soil by the not harvested beet roots. The not harvested root material adds carbon that temporarily ties up the soil nitrogen because of the stimulation of the micro-organisms in the soil. In 2020, there was enough soil moisture for optimum corn growth and microbial activity to overcome the tie up of the soil N. In 2021, the dry fall conditions slowed both the corn growth and the microbial activity so the extra N applied could not overcome the tie up of soil N.

Photo 1. Renville site on October 26^{th}, 2017, during sugar beet harvest prior to planting the field corn in 2018.

Photo 2. Image taken at planting at the Cosmos site showing beet residue from the previous year in plots that were not harvested.

Photo 3. Drone image taken on July 15th, 2020, at the Murdock site showing differences in crop color and height.

Photo 4. Drone image taken on July 1st, 2022, at the Maynard site showing differences in crop canopy fill and color.

Dairy Manure in a Sugar Beet Rotation

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Sugar beets require high soil nitrogen content early in the growing season but benefit from low soil nitrogen later in the season to improve sugar quality. Manure tends to release nitrogen throughout the whole growing season, however, making it difficult to use as a nutrient source when applied prior to sugar beets. But what about if manure is used in other parts of the crop rotation?

Research Objective

- This research aims to evaluate liquid dairy manure application in a sugar beet-soybean-corn rotation. And not just any dairy manure, but manure that has gone through a liquid/solid separation process! Liquid/solid separation is a newer technology that is starting to be used more widely across Minnesota to reduce the volume of manure that needs to be land-applied.

Methodology

Please use the following link to view the methodology and results of this multiyear trial that is still in progress:
https://z.umn.edu/ManureSugarbeet

Photo 1. Drone image of the 2022 manure trial taken on Oct. 4th.

Southern Minnesota Agricultural Research

Nitrogen Rate and Placement Trials

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Nitrogen management is a priority for production of high-quality sugar beets. The use of nitrogen placement could offset the input cost of nitrogen and lower the overall use rate through more efficient use and availability.

Research Objective

- Provide nitrogen fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

Methodology

Two trials were established in 2022 using randomized complete block design. One trial was located north of Renville following soybean and the other trial was located south of Renville following field corn. Both sites were soil sampled in the fall of 2021 to develop treatment rates for the trials in 2022 (Table 1). The treatments for each site were not identical but shared similar treatments which included broadcast urea rates, placement of liquid 32% N (UAN), and use of nitrogen fixing biological products (Tables 2 and 3). Both trial sites were planted on May 24th using Crystal M089. Prior to planting, the urea treatments were broadcast by hand and worked in with a small field cultivator. The liquid 32% N treatments were applied at planting using a 360 Bandit system and CO_2 as a propellant for the fertilizer. The 360 Bandit dribbles the liquid three inches either side of the row at a depth of 0.75 to one inch (Photo 2). For the surface dribble treatment, the hoses were removed from the disc and allowed to drag along the soil surface (Photo 3). The biological nitrogen fixing treatments were applied on June 17th for both trials using a bicycle sprayer. The bicycle sprayer was equipped with XR11002 nozzles with a spray volume of 17gpa. Standard sugar beet production practices were used to keep the trial weed and disease free (Photo 1). Each plot was 35ft long and 6 rows wide. The center two rows of each six-row plot were harvested on September 19th for Renville South and October 13th for Renville North using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Table 1. Soil test results for the two trial locations from fall soil sample in 2021.

Soil test	Renville North	Renville South
Soil nitrate-N 0-4 ft. (lb N/A)	45	45
Olsen P 0-6 in. (ppm)	7.5	13
K 0-6 in. (ppm)	128	222
pH 0-6 in. (unitless)	7.8	7.3
Organic matter 0-6 in. (%)	5.6	4.0

Photo 1. Drone image of Renville North trial on September 28th.

Photos 2 & 3. The 360 Bandit system installed on the 6-row research planter. The dribble treatment visible in the soil surface after planting at the Renville South trial.

Results

The site north of Renville following soybean showed no significant responses for any of the yield or quality parameters (Table 2). The site south of Renville following field corn only responded to N application for extractable sugar per acre (Table 3). For the differences in extractable sugar per acre (ESA), the check, which had no additional nitrogen applied, had lower ESA than most of the other treatments.

Conclusions

The results of these trials are not entirely surprising. In the last decade of nitrogen research at SMBSC, most nitrogen trials fail to generate a positive response to the addition of more nitrogen over the residual nitrogen that's already present in the field. In the most recent years, trials following field corn have generally had a greater response to additional nitrogen compared to trials following soybean. Because of the lack of response to the addition of nitrogen, the comparison of methods of application cannot be made at the site located south of Renville while the response to nitrogen for extractable sugar per acre at the northern site was to the addition of the first unit of nitrogen. There were no statistical differences between the application methods. These nitrogen placement trials will be conducted again in 2023.

SMBSC Southern Minnesota Agricultural Research

Table 2. Yield and quality data for the site north of Renville following soybean harvested on October 13th.

Entry	Treatment	Applied N	Total N	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	Check	0	45	16.2	31.6	13.1	262.4	8294.9	88.2
2	Broadcast Urea	30	75	16.6	32.2	13.6	271.9	8749.2	88.8
3	Broadcast Urea	60	105	16.5	31.7	13.6	271.2	8591.8	88.7
4	Broadcast Urea	90	135	16.4	33.1	13.5	270.6	8960.5	89.2
5	Broadcast Urea	120	165	16.6	32.1	13.6	271.9	8739.4	88.8
6	Broadcast Urea	150	195	16.0	31.5	13.1	262.3	8254.0	88.7
7	Broadcast Urea	180	225	16.5	32.1	13.7	273.9	8801.8	89.5
8	Broadcast Urea	210	255	16.7	30.1	13.8	276.3	8331.6	89.3
9	2x2	30	75	16.3	32.6	13.3	265.7	8677.4	88.5
10	2x2	60	105	16.3	32.9	13.3	265.6	8724.1	88.3
11	Urea + Utrisha N	30	75	16.4	32.8	13.4	267.8	8784.9	88.3
12	Urea + Envita	30	75	16.2	32.6	13.2	263.0	8583.8	88.1
13	2x0 Dribble	30	75	16.4	32.1	13.4	268.6	8611.1	88.6
14	2x0 Dribble	60	105	16.5	32.7	13.6	271.6	8866.2	89.0
			Mean	16.4	32.1	13.4	268.8	8640.8	88.7
			CV%	2.4	5.3	3.7	3.7	6.6	1.0
			Pr>F	0.29	0.27	0.29	0.29	0.61	0.20
			lsd(0.05)	ns	ns	ns	ns	ns	ns

Table 3. Yield and quality data for the site south of Renville following field corn harvested on September 19th.

Entry	Treatment	Applied N	Total N	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	Check	0	45	14.6	34.4	11.8	235.4	8070.2 c	88.6
2	Broadcast Urea	30	75	14.8	37.8	12.3	244.9	9254.4 a	89.6
3	Broadcast Urea	60	105	14.8	38.4	12.0	240.5	9237.1 a	88.6
4	Broadcast Urea	90	135	14.8	39.3	11.9	237.7	9347.5 a	88.0
5	2x2	30	75	14.8	36.3	12.1	240.9	8738.2 abc	88.7
6	2x2	60	105	14.9	36.7	12.2	244.2	8965.6 ab	89.0
7	2x2	90	135	14.8	39.2	12.2	243.2	9534.3 a	89.3
8	Urea + Entiva	30	75	14.8	37.9	12.0	239.0	9045.5 ab	88.1
9	Urea + Utrisha N	30	75	14.7	39.8	11.9	236.8	9408.2 a	88.3
10	Urea + Terramar	30	75	15.0	38.0	12.1	242.9	9253.1 a	88.5
11	2x0 Dribble	60	105	14.5	37.4	11.7	233.3	8722.2 abc	88.3
12	2x0 Dribble	90	135	14.6	38.4	11.9	237.6	9114.5 ab	89.0
			Mean	14.7	37.6	12.0	239.5	9006.4	88.7
			CV%	2.0	6.4	2.5	2.5	6.3	0.8
			Pr>F	0.38	0.11	0.18	0.18	0.03	0.09
			lsd(0.05)	ns	ns	ns	ns	812.5	ns

Phosphorus by Nitrogen Rate Trial

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Nitrogen management is a priority for production of high-quality sugar beets. However, many other nutrients also play a role in plant growth. It is important to understand how the availability of other major nutrients may be impacted by varying levels of nitrogen.

Research Objective

- Provide phosphorus and nitrogen fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

Methodology

This trial was conducted as a 3 x 5 factorial with four replications following field corn west of Redwood Falls, MN. Soil samples were taken in the spring prior to treatment application (Table 1). The nitrogen fertilizer rates were 0, 63, and 133 lb N/A. The phosphorus fertilizer rates were 0, 15, 30, 45, and 60 lb P/A. The phosphorus and nitrogen treatments were applied broadcast in the spring and incorporated using a small field cultivator. The nitrogen source was urea, and the phosphorus source was triple super phosphate (TSP). The site was planted on June 3rd using Crystal M089. Dual Magnum and ethofumesate were applied as a pre emerge and Sequence as a layby application with Roundup Powermax to keep the site weed free. The center two rows of each six-row plot were harvested on October 6th using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Table 1. Soil test results for Redwood Falls location from fall soil sample in 2021.

Soil test	Redwood Falls
Soil nitrate-N 0-2 ft. (lb N/A)	77
Olsen P 0-6 in. (ppm)	14
K 0-6 in. (ppm)	228
pH 0-6 in. (unitless)	7.7
Organic matter 0-6 in. (%)	5.6

Figure 1. Drone images from July 1st and July 15th.

Results

The application of phosphorus had no impact on the yield or quality of sugar beets regardless of the amount of nitrogen applied (Table 2). The increased rate of nitrogen applied had a positive impact on extractable sugar per acre (Table 3). Drone images taken during in July do not show drastic differences in canopy color or size between treatments (Figure 1).

Table 2. The effect of fertilizer P on root yield and quality averaged across N rates.

Phosphorus Rates	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	17.0	33.3	13.9	277.4	9224.2	88.3
15	17.1	32.4	14.0	279.1	9037.2	88.3
30	17.1	33.0	14.0	279.7	9214.9	88.4
45	17.1	33.6	14.0	280.6	9414.9	88.6
60	16.8	33.4	13.7	273.4	9133.0	88.1
Mean	17.0	33.1	13.9	278.0	9204.9	88.3
CV%	2.0	4.7	2.7	2.7	4.4	0.6
Pr>F	0.1991	0.3882	0.1543	0.1543	0.2465	0.2832
lsd (0.05)	ns	ns	ns	ns	ns	ns

Table 3. The effect of fertilizer N on root yield and quality averaged across P rates.

Nitrogen Rates	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	16.94 b	31.9 b	13.8	276.4	8814.8 b	88.3
63	16.96 b	33.9 a	13.8	276.3	9373.7 a	88.2
133	17.21 a	33.5 a	14.1	281.5	9426.1 a	88.4
Mean	17.0	33.1	13.9	278.0	9204.9	88.3
CV%	2.0	4.7	2.7	2.7	4.4	0.6
Pr>F	0.033	0.0004	0.0512	0.0512	<.0001	0.5104
lsd (0.05)	0.2	1.0	ns	ns	259.6	ns

Conclusions

No response was seen to increasing the rate of phosphorus applied with any rate of nitrogen. It was speculated that as nitrogen rates increase that the rates of other nutrients, such as phosphorus, would also need to be increased. Based upon the results of this study increasing phosphorus rates as nitrogen rates increase does not have any impact.

SMBSC Southern Minnesota Agricultural Research

Potassium by Nitrogen Rate Trial

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Nitrogen management is a priority for production of high-quality sugar beets. However, many other nutrients also play a role in plant growth. It is important to understand how the availability of other major nutrients may be impacted by varying levels of nitrogen.

Research Objective

- Provide potassium and nitrogen fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

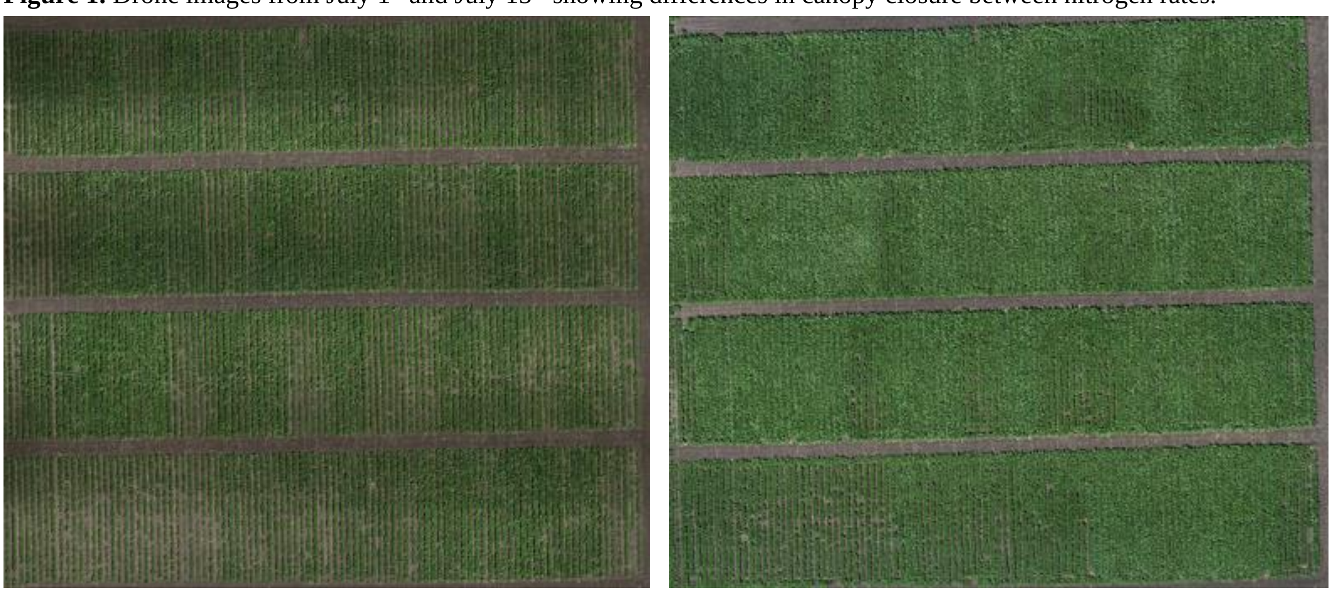
Methodology

This trial was conducted as a 3 x 5 factorial with four replications following field corn west of Redwood Falls, MN. Soil samples were taken in the spring prior to treatment application (Table 1). The nitrogen fertilizer rates were 0, 63, and 133 lb N/A. The potassium fertilizer rates were 0, 30, 60, 90, and 120 lb K/A. The potassium and nitrogen treatments were applied broadcast in the spring and incorporated using a small field cultivator. The nitrogen source was urea, and the potassium source was potash. The site was planted on May 16th using Crystal M089. Dual Magnum and ethofumesate were applied as a pre emerge and Sequence as a layby application with Roundup Powermax to keep the site weed free. The center two rows of each six-row plot were harvested on October 6th using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the SMBSC tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Table 1. Soil test results for Redwood Falls location from fall soil sample in 2021.

Soil test	Redwood Falls
Soil nitrate-N 0-2 ft. (lb N/A)	77
Olsen P 0-6 in. (ppm)	14
K 0-6 in. (ppm)	228
pH 0-6 in. (unitless)	7.7
Organic matter 0-6 in. (%)	5.6

Figure 1. Drone images from July 1st and July 15th showing differences in canopy closure between nitrogen rates.



Results

The application of potassium had no impact on the yield or quality of sugar beets regardless of the amount of nitrogen applied (Table 2). The increased rate of nitrogen applied had a positive impact on extractable sugar per acre (Table 3). Nitrogen rates also had a visual impact on canopy closure (Figure 1).

Table 2. The effect of fertilizer K on root yield and quality averaged across N rates.

Potassium Rates	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	17.6	34.1	14.4	288.8	9823.2	88.6
30	17.7	33.7	14.5	290.5	9774.2	88.6
60	17.6	33.9	14.5	289.6	9795.5	88.8
90	17.6	35.1	14.5	290.0	10169.5	88.7
120	17.9	33.8	14.7	294.2	9886.9	88.6
Mean	17.7	34.1	14.5	290.6	9889.9	88.7
CV%	3.5	6.9	4.4	4.4	6.5	0.6
Pr>F	0.7389	0.584	0.8611	0.8611	0.5538	0.7817
lsd (0.05)	ns	ns	ns	ns	ns	ns

Table 3. The effect of fertilizer N on root yield and quality averaged across K rates.

Nitrogen Rates	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
0	17.3 b	31.0 b	14.2 b	283.4 b	8786.6 c	88.3 b
63	17.6 b	35.5 a	14.4 b	288.3 b	10192.0 b	88.6 b
133	18.1 a	35.9 a	15.0 a	300.2 a	10691.0 a	89.1 a
Mean	17.7	34.1	14.5	290.6	9889.9	88.7
CV%	3.5	6.9	4.4	4.4	6.5	0.6
Pr>F	0.0011	<.0001	0.0005	0.0005	<.0001	0.0003
lsd (0.05)	0.4	1.5	0.4	8.1	409.2	0.4

Conclusions

No response was seen to increasing the rate of potassium applied with any rate of nitrogen. It was speculated that as nitrogen rates increase that the rates of other nutrients, such as potassium, would also need to be increased. Based upon the results of this study and the results of a similar study conducted in 2021, increasing potassium rates as nitrogen rates increase does not have any impact.

SMBSC Southern Minnesota Agricultural Research

Rhizoctonia Trials

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Rhizoctonia root rot can negatively impact plant stand by causing seedling damping off in the spring, but it can also cause a reduction in quality and yield from late season infections. This reduction in quality can having a negative impact on factory operations as well as the storage of the beets in piles.

Research Objective

- To screen new products for control of rhizoctonia root rot and develop recommendations for best management practices.

Methodology

Two trials were conducted near Renville to screen products for control of rhizoctonia and to compare best management practices. The trials were planted on May 10th using Crystal M089. Prior to planting, the site was broadcast with ground barley infected with rhizoctonia provided by Dr. Chanda. The barley was then incorporated with a small field cultivator. Normal agronomic practices were used to keep the trials weed free. These trials were designed as randomized complete blocks with four replications and ten treatments in each trial (Table 1&2). Each plot consisted of six rows that were 35ft in length. Post applications were made using a custom-made bike sprayer on June 10th when the beets were at the 4-6 leaf stage (Photo 1). Post applications were made broadcast or in a 7-inch band depending upon the treatment. The sprayer used CO2 as a propellant and was designed to apply the treatment to the center four rows, leaving rows one and six untreated. Stand counts were taken on the center two rows in the spring and again prior to harvest. The center two rows of each six-row plot were also harvested for yield and quality analysis on September 15th using a six-row defoliator and a two-row research harvester. The beets harvested from the center two rows were weighed on the harvester and samples of those beets were used for a quality analysis at the SMBSC tare lab. The beets on the harvester were also rated for root rot using a 1-7 scale. 1 being free of disease and 7 being severely rotten beets. The data was analyzed for significance using SAS GLM version 9.4.

Photo 1. Post treatment being banded across a plot using a bike sprayer on June 10th.

Table 1. Treatment list and rates for Trial 1.

Entry	Entry Description	Infurrow	Post
1	Control	n/a	n/a
2	4-6 leaf Excalia Banded	n/a	0.64oz
3	4-6 leaf Quadris Banded	n/a	14.3oz
4	4-6 leaf Excalia Broadcast	n/a	2oz
5	4-6 leaf Quadris Broadcast	n/a	14.3oz
6	Azteriod Infurrow fb 4-6 leaf Excalia Broadcast	5.7oz	2oz
7	Azteriod Infurrow fb 4-6 leaf Quadris Broadcast	5.7oz	14.3oz
8	Azteriod Infurrow	5.7oz	n/a
9	Elatus Infurrow	7oz	n/a
10	Elatus Banded	n/a	.301oz/1000 rowft

Table 2. Treatment list and rates for Trial 2.

Entry	Entry Description	Infurrow	Post
1	Control	n/a	n/a
2	4-6 leaf Quadris	n/a	14.3oz
3	Azteroid Infurrow	5.7oz	n/a
4	4-6 leaf Azterknot	n/a	16.5oz
5	Azteriod Infurrow fb 4-6 leaf Azterknot	5.7oz	16.5oz
6	4-6 leaf Howler	n/a	2lbs
7	Howler Infurrow	2lbs	n/a
8	Howler Infurrow fb 4-6 leaf Howler	1lb	1lb
9	Azteriod Infurrow fb 4-6 leaf Proline	5.7oz	5.7oz
10	Azteriod+Minuet Infurrow fb 4-6 leaf Proline	5.7oz+12oz	5.7oz

Table 3. Yield, rot, and stand count data results for Trial 1.

Entry	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity	Harvester Rot Rating	28 DAP Stand Count 100' row	Harvest Stand Count 100' row
1	14.5	28.1	11.7	234.6	6583.3	88.5	2.6 ab	122.5	100.5
2	14.1	27.4	11.2	223.8	6139.5	87.6	2.5 abc	103.8	96.3
3	14.2	28.8	11.4	228.6	6599.9	88.0	2.9 a	115.0	98.5
4	14.2	28.2	11.2	223.9	6301.7	87.2	1.8 bcd	95.0	94.3
5	14.5	29.4	11.6	232.6	6836.9	87.8	2.5 abc	137.5	123.3
6	13.7	28.8	10.8	216.2	6360.8	87.0	1.1 d	81.3	93.3
7	13.7	26.0	10.9	218.0	5674.1	87.8	1.6 cd	87.5	90.0
8	13.9	30.2	11.2	224.4	6683.6	88.2	1.9 bcd	91.3	105.3
9	14.5	27.5	11.8	235.8	6494.2	88.6	1.5 d	105.0	99.0
10	13.8	28.7	11.0	219.4	6301.3	87.5	2.6 ab	127.5	98.5
Mean	14.1	28.2	11.3	225.7	6391.0	87.8	2.1	106.6	99.9
CV%	3.8	8.9	5.0	5.0	11.3	0.9	30.7	29.7	22.4
Pr>F	0.1851	0.7281	0.1862	0.1911	0.6479	0.1413	0.0065	0.2491	0.7176
lsd(0.05)	ns	ns	ns	ns	ns	ns	0.9	ns	ns

Table 4. Yield, rot, and stand count data results for Trial 2.

Entry	Sugar	Tons per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity	Harvester Rot Rating	28 DAP Stand Count 100' row	Harvest Stand Count 100' row
1	14.5	30.0	11.9	238.1	7135.2	89.4	1.9 cde	122.5	110.8
2	14.1	30.0	11.2	224.0	6701.4	87.6	2.8 ab	132.5	106.0
3	14.4	29.5	11.6	232.0	6842.9	88.3	1.8 de	130.0	106.0
4	14.6	29.8	11.6	232.2	6930.1	87.7	2.3 abcde	136.3	110.5
5	14.8	33.4	11.9	238.3	7910.1	88.0	1.7 de	130.0	118.3
6	14.6	31.2	11.8	236.0	7342.2	88.3	2.9 a	148.8	124.3
7	14.4	30.1	11.5	230.8	6953.0	87.8	2.6 abc	115.0	112.3
8	14.2	30.0	11.4	226.8	6740.1	88.0	2.5 abcd	112.5	96.0
9	15.0	29.1	12.2	243.2	7076.5	88.5	1.5 e	117.5	110.5
10	14.7	29.9	11.8	235.2	7024.9	87.9	2.0 bcde	111.3	99.3
Mean	14.5	30.1	11.7	233.5	7036.8	88.1	2.2	125.5	109.2
CV%	4.0	6.5	5.1	5.1	8.0	1.0	27.0	22.0	18.4
Pr>F	0.5978	0.7589	0.5267	0.5283	0.6846	0.2263	0.0284	0.6654	0.7920
lsd(0.05)	ns	ns	ns	ns	ns	ns	0.9	ns	ns

Results

No differences were observed in either trial for yield or quality data (Tables 3 and 4). Stand count data was similarly nonsignificant. The only significant difference in either trial was the harvester rot rating. In Trial 1, all four of the treatments applied infurrow had a significantly better rot rating than the control. In Trial 2, no treatment had a significantly better rot rating than the control, however there were some differences between other treatments with the infurrow treatments generally having a lower rot rating.

Conclusions

While there were not any significant differences for most of the parameters tested, it is worthwhile to note the lower rot ratings of the infurrow treatments over treatments applied at the 4-6 leaf stage. The 2022 planting was delayed due to a wet spring, but after planting significant rainfall events were scarce and many growers in the area struggled to get activating rain for pesticide products. These trials would indicate that in a dry spring, infurrow products may outperform post products simply due to the lack of activating rain.

SMBSC Southern Minnesota Agricultural Research

TURNING POINT SURVEY OF WEED CONTROL AND PRODUCTION PRACTICES IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2022

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The seventh annual weed control and production practices live polling questionnaire was conducted using Turning Point Technology at the 2023 winter Sugarbeet Grower Seminars. Responses are based on production practices from the 2022 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 in North Dakota and Minnesota indicated the county in which the majority of their sugarbeet were produced (Tables 1, 2, 3, 4, 5). Survey results represent approximately 207,360 acres reported by 246 respondents (Table 6) compared with 162,042 acres represented in 2021. The average sugarbeet acreage per respondent grown in 2022 was calculated from Table 6 at 843 acres compared with 965 acres in 2021.

Survey participants were asked a series of questions regarding their production practices used in sugarbeet in 2022. Growers were asked about their tillage practices for sugarbeet in 2022 (Table 7). Ninety-seven percent of all respondents indicated conventional tillage as their primary with 1% practicing strip tillage and 2% using no tillage. Across locations, 53% of respondents indicated wheat was the crop preceding sugarbeet (Table 8), 28% indicated corn (field or sweet), and 13% indicated soybean. Preceding crop varied by location with 81% of Grand Forks growers indicating wheat preceded sugarbeet and 84% of Willmar growers indicated corn as their preceding crop. Seventy-five percent of growers who participated in the winter meetings used a nurse or cover crop in 2022 (Table 9) which decreased from 82% in 2021. Cover crop species also varied widely by location with barley being used by 52% and 59% of growers at the Grand Forks and Wahpeton meeting, respectively, and oat being used by 50% of growers at the Willmar meeting.

Growers indicated weeds were their most serious production problem in sugarbeet for the second year in a row (Table 10) with 55% of participants in 2022 as compared with 32% of participants in 2021. In 2022, emergence or stand was the most serious problem overall for 18% of respondents. Cercospora leaf spot (CLS) was named as most serious overall by 8% of respondents across locations; however, was the most serious problem for 27% of participants in the Grafton location.

Waterhemp was named as the most serious weed problem in sugarbeet for the third year in a row by 73% of respondents in 2022 (Table 11) compared with 73% in 2021 and 54% in 2019. Fourteen percent of respondents indicated kochia, 6% said common ragweed, and 2% of respondents indicated common lambsquarters were their most serious weed problem in 2022. The increased presence of glyphosate-resistant waterhemp and kochia, along with a dry growing season in 2022, are likely the reasons for these weeds being named as the worst weeds. Troublesome weeds varied by location with 100%, 89%, and 88% of Willmar, Wahpeton, and Fargo respondents, respectively, indicating waterhemp was most problematic weed. Kochia was the worst weed for respondents of the Grafton meeting with 57% of responses.

Respondents to the survey indicated making 0 to 4 glyphosate applications in their 2022 sugarbeet crop (Table 12) with a calculated average of 2.08 applications per acre. The calculated average in 2021 was 1.99 applications per acre.

Glyphosate was most commonly applied with a chloroacetamide herbicide postemergence (lay-by) in 2022 with 49% of responses indicating this herbicide combination was used (Table 13). Glyphosate applied with a broadleaf herbicide postemergence was the second most common herbicide used in sugarbeet in 2022 with 31% of responses.

Glyphosate alone and glyphosate plus a grass herbicide were the third and fourth most common at 14% and 5% of the responses, respectively.

Preplant incorporated (PPI) or preemergence (PRE) herbicides were applied by 71% of survey respondents in 2022 (Table 14). Thirty-seven percent of Grafton survey participants applied a PPI or PRE herbicide compared with 31% in 2021. Conversely, 98% of Wahpeton survey participants applied a PPI or PRE herbicide in sugarbeet in 2022 compared with 90% in 2021. Once again, a likely reason for this variation is the more common presence of glyphosate-resistant waterhemp in the southern sugarbeet growing areas of the Red River Valley compared with the north end of the Valley. The most commonly used soil-applied herbicide was *S*-metolachlor with 24% of all responses followed by a combination of *S*-metolachlor plus ethofumesate with 22% of responses that utilized a PPI or PRE. Of the growers who indicated using a soil-applied herbicide, 46% indicated excellent to good weed control from that herbicide (calculated from Table 15).

The application of soil-residual herbicides applied 'lay-by' to the 2022 sugarbeet crop was indicated by 79% of respondents (Table 16). *S*-metolachlor and Outlook were the most commonly applied lay-by herbicides with 36% of responses. The majority of growers responding at the Willmar meeting indicated using Outlook (78% of responses), while S-metolachlor was more commonly applied by growers of the Fargo (73% of responses) and Wahpeton (61% of responses) meetings.

The Environmental Protection Agency (EPA) approved a second request for a Section 18 emergency exemption for Ultra Blazer (acifluorfen) in 2022. This provided Minnesota and eastern North Dakota sugarbeet growers a postemergence herbicide to control glyphosate-resistant waterhemp in sugarbeet. The exemption allowed a single Ultra Blazer application at 16 fluid ounces per acre per year. A Section 18 exemption under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes EPA to allow an unregistered use of a pesticide for a limited time if EPA determines that an emergency condition exists. Twenty-three percent of respondents applied Ultra Blazer in 2022 as compared with 37% of respondents in 2021 (data not shown). Of the growers who used Ultra Blazer, 2% applied Ultra Blazer alone, 10% applied Ultra Blazer with NIS, and 6% tank mixed Ultra Blazer with glyphosate, NIS, and AMS.

Growers' were asked about additional POST weed control methods used in 2022 (Table 17). Hand-weeding and row-crop cultivation were the two most common practices with 40% of respondents hand-weeding and 24% of respondents implementing row-crop cultivation. Thirty-nine percent of respondents had some acres hand-weeded (calculated from Table 18). However, most respondents indicated less than ten percent of their acres were hand-weeded. Sixty-two percent of participants reported row-crop cultivation (calculated from Table 19). However, most respondents indicated less than ten percent of their acres were cultivated. Conversely, 7% reported row-crop cultivation on 100% of their acres.

Table 1. 2023 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2022.

County	Number of Responses	Percent of Responses
Cass	3	10
Clay	11	38
Norman[1]	10	35
Traill	5	17
Total	29	100

[1]Includes Mahnomen County

Table 2. 2023 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2022.

County	Number of Responses	Percent of Responses
Grand Forks	4	8
Kittson	6	12
Marshall	6	12
Pembina	14	28
Walsh	19	38
Other	1	2
Total	50	100

Table 3. 2023 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2022.

County	Number of Responses	Percent of Responses
Grand Forks	15	25
Marshall	4	6
Nelson	2	3
Polk	29	48
Traill	3	5
Walsh	3	5
Other	5	8
Total	61	100

Table 4. 2023 Wahpeton Grower Seminar - Number of survey respondents by county growing sugarbeet in 2022.

County	Number of Responses	Percent of Responses
Cass	1	2
Clay	3	7
Grant	4	10
Richland	11	26
Traverse	3	7
Wilkin	20	48
Total	42	100

Table 5. 2023 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2022.

County	Number of Responses	Percent of Responses
Chippewa	30	40
Kandiyohi	7	9
Redwood	2	3
Renville	22	29
Stearns	1	1
Stevens	2	3
Swift	6	8
Other	5	7
Total	75	100

Table 6. Total sugarbeet acreage operated by respondents in 2022.

		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	23	0	0	4	22	26	17	4	13	4	10
Grafton	46	2	11	7	15	17	11	9	15	9	4
Grand Forks	63	3	10	6	7	29	16	16	13	0	0
Wahpeton[1]	41	0	12	0	0	22	0	24	0	42	0
Willmar	73	7	11	15	11	18	12	10	10	4	2
Total	246	3	10	8	10	22	11	13	10	10	2

[1]Acreage categories were <250, 250-500, 500-750, or >750.

Table 7. Tillage system used in sugarbeet in 2022.

Location	Responses	Conventional Tillage	Strip Tillage	No Tillage
		--------------------% of responses-----------------		
Fargo	23	100	0	0
Grafton	47	96	2	2
Grand Forks	62	96	2	2
Wahpeton	41	98	1	1
Willmar	73	97	3	0
Total	246	97	1	2

Table 8. Crop grown in 2021 that preceded sugarbeet in 2022.

		Previous Crop						
Location	Responses	Sweet Corn	Field Corn	Dry Bean	Potato	Soybean	Wheat	Other
		-------------------------------% of responses--------------------------------------						
Fargo	27	4	0	0	0	14	78	4
Grafton	44	0	0	9	9	2	80	0
Grand Forks	64	0	0	0	6	11	81	2
Wahpeton	41	0	21	0	0	24	55	0
Willmar	73	70	14	0	0	15	1	0
Total	250	24	4	2	3	13	53	1

Table 9. Nurse or cover crop used in sugarbeet in 2022.

Location	Responses	Spring Barley	Spring Oat	Winter Rye	Spring Wheat	Winter Wheat	Other[1]	None
		--------------------------------% of responses-----------------------------------						
Fargo	26	38	0	0	4	0	0	58
Grafton	42	36	5	2	22	2	0	33
Grand Forks	62	52	0	8	13	0	0	27
Wahpeton	41	59	0	17	4	0	0	20
Willmar	72	0	50	3	36	0	0	11
Total	243	33	16	6	19	1	0	25

[1]Includes Mustard and 'Other'.

Table 10. Most serious production problem in sugarbeet in 2022.

Location	Responses	CLS[1]	Rhizo-mania	Aph[2]	Rhizoc-tonia	Fusarium	Herbicide Injury	Root Maggot	Weeds	Stand[3]
		----------------------------------% of responses---								
Fargo	24	8	0	0	0	0	13	4	58	17
Grafton	42	27	2	2	7	0	0	7	43	12
Grand Forks	59	3	0	0	8	0	0	10	65	14
Wahpeton	40	3	0	0	27[4]	0	0	0	27	43
Willmar	76	5	3	1	12	0	0	0	67	12
Total	241	8	1	5	7	0	1	4	55	18

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

Table 11. Most serious weed problem in sugarbeet in 2022.

Location	Responses	grasses	colq[1]	cora	kochia	gira	rrpw	RR Canola	wahe	other
		-----------------------------------% of responses---								
Fargo	25	0	0	8	0	0	0	4	88	0
Grafton	48	0	8	8	57	0	2	0	23	2
Grand Forks	62	0	2	12	12	2	2	0	70	0
Wahpeton	38	0	3	0	5	0	3	0	89	0
Willmar	69	0	0	0	0	0	0	0	100	0
Total	242	0	2	6	14	1	2	1	73	1

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

Table 12. Average number of glyphosate applications per acre in sugarbeet during 2022 season.

Location	Responses	0	1	2	3	4	5
		-------------------------% of responses-------------------------------					
Fargo	24	4	25	58	13	0	0
Grafton	47	0	17	51	30	2	0
Grand Forks	62	0	15	66	19	0	0
Wahpeton	41	3	20	63	14	0	0
Willmar[1]	75	0	0	75	25	0	0
Total	249	1	12	65	21	1	0

Table 13. Herbicides used in a weed control systems approach in sugarbeet in 2022.

Location	Responses	Glyphosate Application Tank-Mixes					
		Gly Alone	Gly+Lay-by	Gly+Broadleaf	Gly+Grass	Other	None Used
		--------------------------------------% of responses-----------------------------------					
Fargo	31	3	52	36	6	3	0
Grafton	50	44	16	36	4	0	0
Grand Forks	72	12	29	51	4	3	1
Wahpeton	42	1	98	-[1]	0	1	0
Willmar	85	8	61	24	7	0	0
Total	280	14	49	31	5	1	0

[1]Most applications included both a lay-by and broadleaf herbicide.

Table 14. Preplant incorporated or preemergence herbicides used in sugarbeet in 2022.

Location	Responses	PPI or PRE Herbicides Applied					
		S-metolachlor	ethofumesate	Ro-Neet SB	S-metolachor +ethofumesate	Other	None
		--------------------------------------% of responses-----------------------------------					
Fargo	34	35	41	3	6	6	9
Grafton	47	11	11	0	11	4	63
Grand Forks	62	27	13	0	7	3	50
Wahpeton	42	43	12	0	43	0	2
Willmar	76	16	29	0	37	2	16
Total	261	24	21	1	22	3	29

Table 15. Satisfaction in weed control from preplant incorporated and preemergence herbicides in 2022.

Location	Responses	PPI or PRE Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		------------------------------% of responses--------------------------					
Fargo	26	15	66	19	0	0	0
Grafton	43	2	35	5	0	0	58
Grand Forks	61	7	34	5	0	2	52
Wahpeton	42	0	50	50	0	0	0
Willmar	71	0	38	33	18	0	11
Total	243	4	42	22	5	0	27

Table 16. Soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2022.

Location	Responses	Lay-by Herbicides Applied			
		S-metolachlor	Outlook	Warrant	None
		--------------------------------------% of responses-----------------------			
Fargo	26	73	19	0	8
Grafton	42	29	2	5	64
Grand Forks	64	52	12	2	34
Wahpeton	41	61	32	0	7
Willmar	86	5	78	16	1
Total	258	36	36	7	21

Table 17. Other POST weed control methods used in 2022.

Location	Responses	Rotary Hoe	Row-Cultivation	Hand Weeding	Other	None
		---% of responses---				
Fargo	25	0	24	56	0	20
Grafton	53	9	23	40	0	28
Grand Forks	81	5	17	56	1	21
Wahpeton	40	25	0	0	12	63
Willmar	75	3	33	34	6	26
Total	274	4	24	40	2	30

Table 18. Percent of sugarbeet acres hand-weeded in 2022.

		% Acres Hand-Weeded				
Location	Responses	0	< 10	10-50	51-100	>100
		---% of responses---				
Fargo	25	36	28	16	12	8
Grafton	48	35	48	13	4	0
Grand Forks	60	20	55	18	5	2
Wahpeton	40	98	2	0	0	0
Willmar	73	25	21	19	16	19
Total	242	61	18	12	2	7

Table 19. Percent of sugarbeet acres row-crop cultivated in 2022.

		% Acres Row-Cultivated				
Location	Responses	0	< 10	10-50	51-100	>100
		---% of responses---				
Fargo	25	56	28	16	0	0
Grafton	46	63	22	9	0	6
Grand Forks	59	51	27	22	0	0
Wahpeton	40	95	5	0	0	0
Willmar	72	49	14	10	8	19
Total	246	38	33	14	8	7

ETHOFUMESATE

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Summary

1. Chemical properties of ethofumesate, including adsorptivity and water solubility, partially explain the inconsistent waterhemp control across environmental conditions.
2. Waterhemp control from ethofumesate is best following timely, adequate, and penetrating rainfall events.
3. Ethofumesate rate alone does not overcome sub-optimal environmental conditions.
4. The use of shallow tillage to incorporate ethofumesate in the top soil may improve the probability for waterhemp control.
5. Moisture in the soil solution is necessary for waterhemp control, even if ethofumesate moves into the soil during tillage.

Introduction

Ethofumesate or ‘Nortron’ was registered by Fisons Corporation in 1977 for control of small seeded broadleaves including common lambsquarters, waterhemp, and redroot pigweed control in sugarbeet (Edwards et al. 2005; Ekins and Cronin 1972). Ethofumesate is applied preplant incorporated (PPI) and preemergence (PRE) at use rates from 1.00 (2 pt/A) to 3.75 (7.5 pt/A) pound per acre (Kellogg 2011) and up to 0.38 (0.75 pt/A) pound per acre postemergence.

Weed control following PRE application requires timely and adequate precipitation to activate ethofumesate in the weed seedling layer due to low water solubility and strong adsorption to soil characteristics as compared to the chloroacetamide family of herbicides, dicamba, and trifluralin (Table 1; Shaner 2014; Schweitzer 1975). Ethofumesate rarely leaches in soil and provides up to 10 weeks of residual control to grass and broadleaf weed species (Ekins and Cronin 1972). Ethofumesate is absorbed through emerging roots and shoots when applied to soil (Eshel et al. 1978).

Table 1. Herbicides behavior in soil.

Common Name	Trade Name	Adsorptivity[a]	Water Solubility[b]
		K_{OC}	ppm[c]
acetochlor	Warrant	200	233
dimethenamid-p	Outlook	155	1,174
S-metolachlor	Dual Magnum	200	488
ethofumesate	Nortron	340	110
trifluralin	Treflan	7,000	0.3
dicamba	XtendiMax	2	4,500

[a]K value represents the ratio of herbicide bound to soil collides versus what is free in the water solution. The higher the K value, the greater the adsorption to soil colloids.
[b]Water solubility is a measure of the amount of chemical substance that can dissolve in water at a specific temperature. For example, milligrams per liter.
[c]ppm=Parts per million

Waterhemp control from ethofumesate has been an enigma (Merriam-Webster Dictionary definition: mysterious, puzzling, or difficult to understand) and it seems our interpretation of ethofumesate becomes more confusing with experiments in more environments. One of our first waterhemp experiments was near Herman, MN in 2014. We observed greater than 85% waterhemp control in July from ethofumesate alone or ethofumesate mixed with Dual Magnum PRE, but found ethofumesate did not provide season-long waterhemp control (Table 2). This outcome led to the development of a layered strategy in sugarbeet beginning with ethofumesate alone or ethofumesate mixtures with Dual Magnum PRE, followed by (fb) the split application of chloroacetamide herbicides at the V2 and V6 sugarbeet stage.

Table 2. Waterhemp control in response to herbicide treatment, Herman MN, 2014.

Treatment[a]	Application	Rate	Waterhemp Control			
			Jun 23	Jul 2	Jul 10	Aug 27
		---pt/A---	----------------------%----------------------			
Ethofumesate	PPI	6	78	90	86	74
Ethofumesate	PRE	6	88	88	86	70
Etho + Dual Magnum	PRE	3 + 0.5	99	99	97	94
Etho + Dual Magnum	PRE	4 + 0.5	98	97	97	94
Etho + Dual Magnum	PRE	3 + 1	98	100	100	98
Etho + Dual Magnum	PRE	4 + 1	100	100	100	98

[a]Treatments included repeat Roundup PowerMax applications POST at 28 fl oz/A followed by (fb) 28 fl oz/A fb 22 fl oz/A + Prefer 90 NIS at 0.25% v/v and N-Pak AMS at 2.5% v/v.

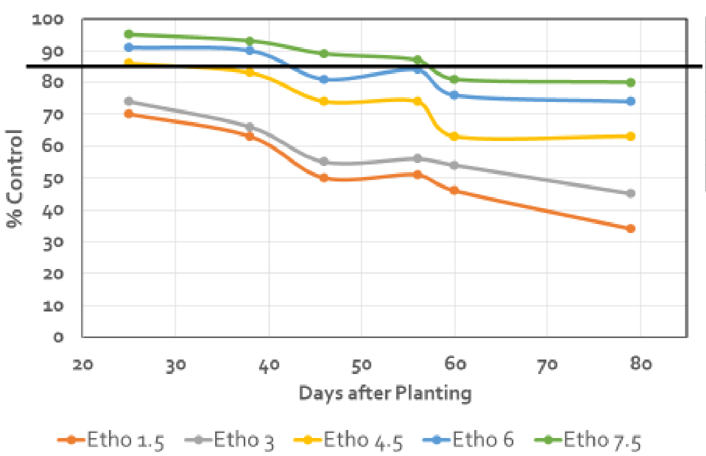
Ethofumesate alone or mixed with Dual Magnum PRE layered with chloroacetamide herbicides consistently controlled waterhemp in field experiments from 2015 to 2019. In general, sugarbeet were planted in May and received sufficient rainfall for activation of soil residual herbicides. However, our promising results did not reflect our historical knowledge, especially Dr. Dexter's research, which found incorporating ethofumesate improved the consistency of pigweed control from ethofumesate. Moreover, Dr. Dexter conducted several experiments over the years comparing preplant ethofumesate with preemergence ethofumesate (Table 3). Dr. Dexter's data suggests the importance of timely rainfall for activating ethofumesate. Finally, he conducted research on the appropriate depth to incorporate ethofumesate as well as comparing tillage equipment for optimal ethofumesate incorporation (Dexter et al., 1982).

Table 3. Comparing preplant incorporated and preemergence ethofumesate at 3.75 to 4.0 lb/A; 1973 to 1986.[a]

Nortron application	Redroot pigweed control at 4 of 7 locations	Redroot pigweed control at 3 of 7 locations
	---------------------------%---------------------------	
PPI	97	91
PRE	79	93
LSD (0.05)	**11**	**NS**

[a]Data taken from NDSU PLSC 350 class notes.

Growers frequently inquired about the maximum ethofumesate rate one can apply without injury to nurse crops. An experiment, first established in 2020, considered waterhemp control in response to ethofumesate rate (Figure 1 and Table 4). The experiment was established near Blomkest and at the ACS Technical Center, Moorhead, MN in 2020. Spring barley was drilled perpendicular to plots sprayed with ethofumesate at 1.5 to 7.5 pt/A. The primary objective was to find the threshold between spring barley safety and waterhemp control. Our second objective was to determine waterhemp control from ethofumesate at various application rates.



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

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

Figure 1. Waterhemp control in response to ethofumesate PRE at 1.5 to 7.5 pt/A, Blomkest MN, 2020.

Our working hypothesis was ethofumesate provides greater than 85% waterhemp control for less than 30 days at 1.5, 3.0 and 4.5 pt/A and greater than 85% waterhemp control for more than 30 days at 6.0 and 7.5 pt/A. That is, complete waterhemp control but for short duration at rates less than 4.5 pt/A. To our surprise, the 1.5 and 3.0 pt/A rates did not accomplish 85% control at either Moorhead or Blomkest. The Moorhead experiment was completely overgrown with waterhemp by July 4, 2020 (Table 4). We attributed the Moorhead results to less than optimal results from ethofumesate in a season where ethofumesate activation by rainfall was compromised by below normal rainfall after planting.

Table 4. Waterhemp control in response to ethofumesate rate, Moorhead MN, 2020

		Waterhemp Control		
Herbicide	**Rate**	**May 26**	**June 15**	**June 28**
	--pt/A--	--------------------------------%--------------------------------		
Ethofumesate	0	8 e	0 d	3 d
Ethofumesate	1.5	38 d	35 c	13 cd
Ethofumesate	3	50 c	51 b	18 c
Ethofumesate	4.5	73 a	68 a	33 b
Ethofumesate	6.0	63 b	70 a	58 a
Ethofumesate	7.5	65 ab	76 a	53 a
LSD (0.20)		**9**	**9**	**14**

This experiment was repeated at two locations in 2021, a location near Hector International Airport, Fargo, ND and a second location at the ACS Technical Center, Moorhead, MN. We elected to include both preplant incorporation and preemergence application in the experimental design in 2021 in response to previous year results with below normal rainfall. We also elected to conduct the experiment at 2, 4, 6, 8, 10 and 12 pt/A ethofumesate. Unfortunately, 2021 was equally as dry as 2020. Conditions were so poor that the experiment at Moorhead was abandoned due to erratic emergence of spring barley. We observed very poor overall control of waterhemp at Fargo location. However, we observed that waterhemp escapes were either small or large plant, depending on treatment, suggesting control of either early or late emerging waterhemp. Ethofumesate PPI, averaged across treatments, provided no control of early emerging waterhemp, but 56% control of late emerging waterhemp (Figure 2). Conversely, ethofumesate PRE, averaged across treatments, provided 55% control of early emerging waterhemp, but only 28% control of late emerging waterhemp.

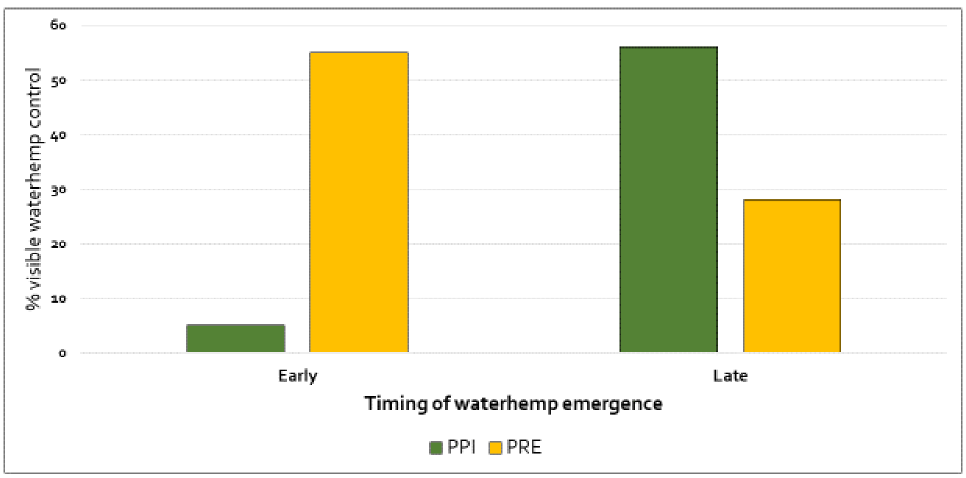


Figure 2. Early and late emerging waterhemp control in response to ethofumesate PPI or PRE, Fargo ND, 2021.

We hypothesize that ethofumesate incorporated into the soil was bound to soil colloids and unavailable for waterhemp uptake early in the season due to sub-optimal soil moisture conditions (Figure 3). However, ethofumesate moved into the soil solution following rain events in June and was partially effective at controlling later emerging waterhemp. Ethofumesate PRE, which likely was bound to the soil surface, may have moved into the soil following rainfall events on May 20 and June 7, providing some early season control. However, degradation likely reduced control of late emerging waterhemp.

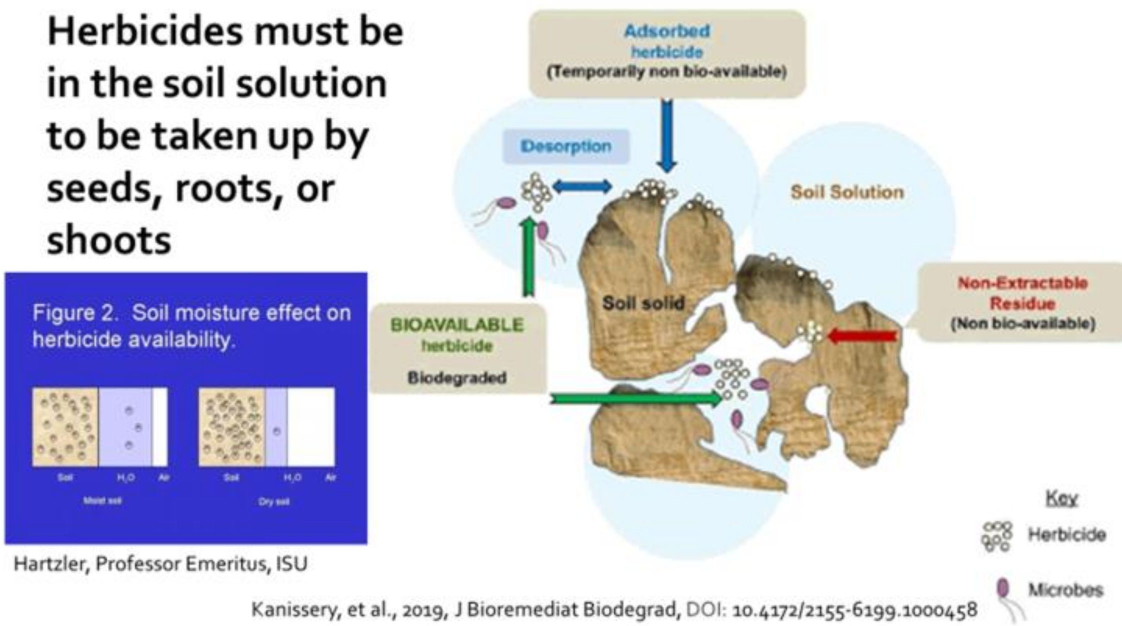


Figure 3. Illustration depicting ethofumesate bound to soil colloids when soil water content is low and in the soil solution when the soil water content is greater.

We believe soil moisture is a predictor of ethofumesate performance and at least partially explains the inconsistent results growers have experienced when ethofumesate has been applied preemergence in some fields in 2021 (and 2022). Likewise, waterhemp control from ethofumesate has been inconsistent even with effective incorporation, when soil moisture levels were sub-optimal such as conditions in some geographies in 2021.

Our working hypothesis is that ethofumesate controls waterhemp best following timely, adequate, and penetrating rainfall events to move ethofumesate off the soil surface and into the water solution and/or spaces between colloids. Ethofumesate rate does not overcome challenges caused by a dry spring. Finally, incorporating ethofumesate might be an effective way for improving waterhemp control, provided ethofumesate is not incorporated too deep, thereby diluting concentration.

The objective of this 2022 experiment was to 1) demonstrate crop safety to nurse crop barley and 2) determine the duration of waterhemp control from ethofumesate.

Materials and Methods

An experiment was conducted near Moorhead, MN in 2022. The experimental area was prepared for planting by fertilizing and conducting tillage across the experimental area. Sugarbeet was planted on May 25 at Moorhead, MN in 2022. Sugarbeet was seeded in 22-inch rows at approximately 62,000 seeds per acre with 4.6 inch spacing between seeds. Herbicide treatments are found in Table 5.

Treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length in 2022. Ethofumesate applied preplant was incorporated into soil using a Kongskilde s-tine field cultivator with rolling baskets set approximately 2-inch deep and operated at approximately 5 mph.

Table 5. Herbicide treatment, application timing, and rate, Moorhead, MN, 2022.

Herbicide Treatment	Application timing	Rate (pt/A)
Ethofumesate	Preplant	2
Ethofumesate	Preplant	4
Ethofumesate	Preplant	6
Ethofumesate	Preplant	8
Ethofumesate	Preplant	10
Ethofumesate	Preplant	12
Ethofumesate	Preemergence	2
Ethofumesate	Preemergence	4
Ethofumesate	Preemergence	6
Ethofumesate	Preemergence	8
Ethofumesate	Preemergence	10
Ethofumesate	Preemergence	12

Visible waterhemp control (0 to 100% control, 0% indicating no control, and 100% indicating complete control) was collected approximately 10 days after treatment (DAT). Experimental design was randomized complete block design with four replications in a factorial arrangement, with factors being herbicide rate and application timing. Data were analyzed with the ANOVA procedure of ARM, version 2022.5 software package.

Results and Discussion

Waterhemp control was evaluated on approximately ten-day intervals from June 16 to August 3, 2022. Figure 4 demonstrates waterhemp control × ethofumesate rate, averaged across application type, since waterhemp control from ethofumesate PPI (preplant incorporated) did not interact with ethofumesate PRE (P-Value = 0.8926, 0.7840, 0.6326, 0.4246, 0.2129 and 0.3762, approximately 20, 30, 40, 50, 60, and 70 DAP (days after planting) evaluation, respectively). Cumulative rainfall was 0.9, 2.6, and 4.5 inches, 14, 30 and 45 DAP and ethofumesate application, in 2022, which was enough to activate the herbicide, regardless of application method, and explains the lack of interaction. However, waterhemp control from ethofumesate at labeled rates failed to reach 85% control.

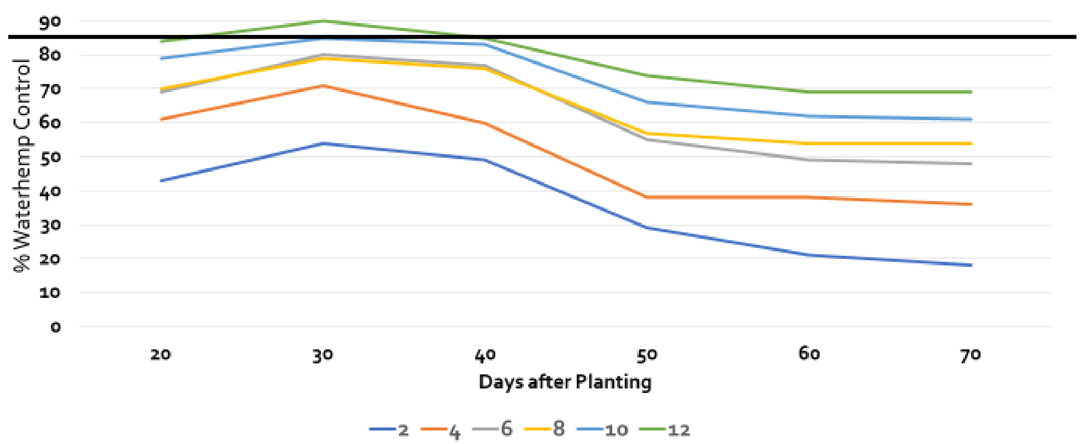


Figure 4. Waterhemp control in response to ethofumesate, averaged across PPI and PRE, Moorhead MN, 2022.

Ethofumesate PPI or PRE is a component in the waterhemp control strategy which includes PRE fb EPOST fb POST application of soil residual herbicides. Sugarbeet reach the 2-lf stage between 14 and 28 DAP, depending on planting date. Ekins and Cronin (1972) reported ethofumesate provides up to 10 weeks of residual broadleaf control. However, Ekins and Cronin did not research waterhemp control. Our 2022 result suggests no more than 6-weeks of waterhemp control (Figure 5) which seems to align with results from previous years.

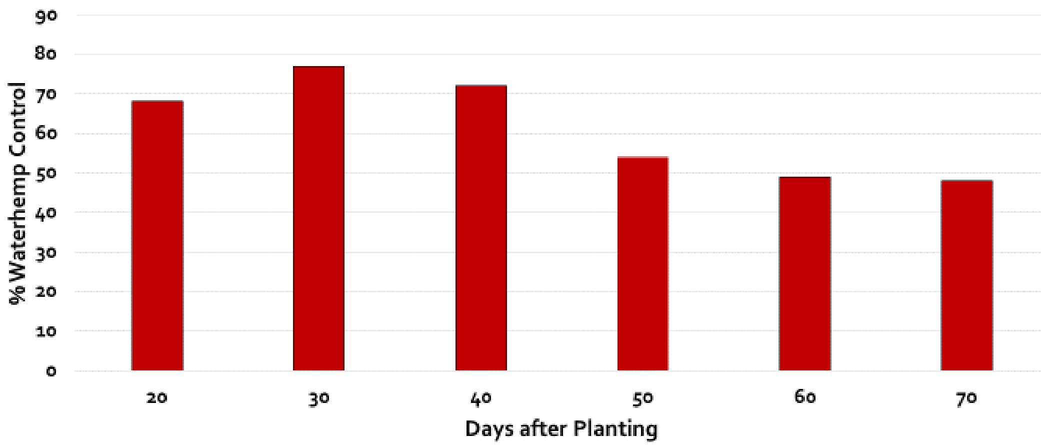


Figure 5. Waterhemp control in response to ethofumesate, averaged across ethofumesate rate and application type, Moorhead MN, 2022

Conclusion

Implementing the layered soil residual strategy is our best opportunity for season-long waterhemp control in sugarbeet. Our best opportunity for a clean start has been an early spring planting date along with an application of ethofumesate alone PRE or ethofumesate mixed with Dual Magnum PRE fb ample rainfall for activation. Our results suggest ethofumesate rate alone does not overcome environmental challenges when timely, adequate, and penetrating rainfall fails to occur. Thus, mixing Dual Magnum with ethofumesate is a strategy to reduce risk, as Dual Magnum adsorbs less to soil and is more water soluble, thus providing short duration control until sufficient rainfall occurs for ethofumesate activation. Incorporating ethofumesate is a risk-aversion strategy, provided ethofumesate is incorporated 0.5- or 1-inch (tillage at 1-inch or 2-inch) with tillage equipment that enables movement of ethofumesate into the soil, thereby maximizing pigweed control.

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SUGARBEET TOLERANCE FROM ULTRA BLAZER

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Summary

1. Environmental conditions at application and adjuvants influence sugarbeet tolerance and waterhemp control.
2. Yield parameters support either repeat Ultra Blazer applications at 12 fl oz/A followed by (fb) 12 fl oz/A with non-ionic surfactant or Ultra Blazer at 16 fl oz/A with Crop Oil Concentrate (COC).
3. Greater sugarbeet injury was observed from Ultra Blazer mixtures with Roundup PowerMax3 in 2022 than with Roundup PowerMax in previous years.
4. Acifluorfen use in sugarbeet requires a compromise between sugarbeet injury and waterhemp control.

Introduction

Ultra Blazer (acifluorfen) was repurposed into sugarbeet in 2019 and 2020 to replace Betamix (desmedipham & phenmedipham) and provide control of glyphosate-resistant (GR) waterhemp in sugarbeet. The Environmental Protection Agency (EPA) approved a request for a Section 18 emergency exemption for Ultra Blazer for control of escaped waterhemp in sugarbeet in Minnesota and eastern North Dakota in 2021 and 2022. The exemption allowed a single Ultra Blazer application at 16 fluid ounces per acre per year, either alone or mixed with Roundup PowerMax(3). A Section 18 exemption under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes EPA to allow an unregistered use of a pesticide for a limited time, if EPA determines that an emergency condition exists.

Our 2022 Ultra Blazer Section 18 emergency exemption label provided flexibility and recommended Ultra Blazer at 16 fl oz/A either alone, with non-ionic surfactant at 0.125% v/v, or mixed with Roundup PowerMax3 and ammonium sulfate at 2.5% v/v, but without NIS, depending on situation (Table 1). However, our challenge has been to optimize waterhemp control without increasing sugarbeet injury. Sugarbeet must be greater than the 6-lf stage and waterhemp less than 4-inches (preferred) for selective control while reducing injury potential.

Table 1. Herbicide treatment, rate, and application timing, Ultra Blazer Section 18 emergency exemption, 2022.

Treatment	Rate (fl oz/A)	Sugarbeet Stage (lvs)
Ultra Blazer	16	>6
Ultra Blazer + Prefer 90 NIS	16 + 0.125% v/v	>6
Ultra Blazer + Roundup PowerMax + Amsol Liquid AMS	16 + 28 + 2.5 % v/v	>6

We have learned that sugarbeet injury increases when oil-based adjuvants or herbicides are mixed with Ultra Blazer. We have also learned that Ultra Blazer is more active on sugarbeet and waterhemp when the maximum day-time temperature is 85°F as compared with 75°F. The objective of this experiment was to determine sugarbeet visible injury, root yield, % sucrose, and recoverable sucrose from Ultra Blazer with adjuvants or mixtures with glyphosate.

Materials and Methods

Experiments conducted near Crookston, Hendrum, Nashua, Lake Lillian, and Murdock, MN in 2022 evaluated sugarbeet tolerance from Ultra Blazer alone or mixed with glyphosate (Roundup PowerMax3). The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in 22-inch rows at about 62,000 seeds per acre with 4.6 inch spacing between seeds. Treatments shown in Table 2 were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length. Environmental conditions at application are in Table 3.

Table 2. Herbicide treatment, herbicide rate, and application timing across locations in 2022.

Herbicide Treatment	Rate (fl oz/A)	Application timing (SGBT leaf stage)
Ultra Blazer + Prefer 90 NIS	16 + 0.25%	6-8 lf
Ultra Blazer + Prefer 90 NIS / Ultra Blazer + Prefer 90 NIS	12 + 0.125% / 12 + 0.125 %	6-8 lf / A + 7-day
Ultra Blazer + Crop Oil Concentrate	16 + 0.25%	6-8 lf
Roundup PowerMax3 + Ultra Blazer + Amsol Liquid AMS	25 + 16 + 2.5% v/v	6-8 lf
Roundup PowerMax3 + Ultra Blazer + Prefer 90 NIS + Amsol Liquid AMS	25 + 16 + 0.25% + 2.5% v/v	6-8 lf
Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS / Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS	25 + 0.25% + 2.5% v/v / 25 + 0.25% + 2.5% v/v	2 lf / 6 lf

Table 3. Application information.

	Crookston	Hendrum	Murdock	Lake Lillian
Date	June 24	July 5	June 22	June 22
Time of Day	10:00 AM	1:00 PM	6:00 AM	4:00 PM
Air Temperature (F)	80	73	-	84
Relative Humidity (%)	57	67	29	29
Wind Velocity (mph)	15	4	6	9
Wind Direction	NNW	NNE	NW	W
Soil Temp. (F at 6”)	70	-	74	-
Soil Moisture	Fair	Dry	Dry	Dry
Cloud Cover (%)	100	100	10	10

Visible sugarbeet necrosis, malformation, and growth reduction were evaluated approximately 7 and 14 days after treatment (DAT) as sugarbeet injury using a 0 to 100% injury scale with 0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stature. All evaluations were a visual estimate of injury in the four treated rows compared to 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). Experimental design was randomized complete block with six replications. Data were analyzed in this report as a RCBD with the ANOVA procedure of ARM, version 2022.5 software package.

Results

Sugarbeet injury was evaluated multiple times throughout the growing season; however, only the evaluation of injury approximately 14 DAT is presented in Table 4. A very heavy rain event at Nashua, 6 days after planting, impacted sugarbeet stand and compromised the experimental area. We, therefore, elected to not present sugarbeet injury or yield data from Nashua, MN, due to variability.

Necrosis injury was evaluated as the percent of sugarbeet leaf area that was bronzed from Ultra Blazer application (Figure 1). Necrosis injury was greatest from repeat Ultra Blazer applications of 12 fl oz/A fb 12 fl oz/A as compared with a single application of 16 fl oz/A and was consistent across locations (Table 4). Application of Roundup PowerMax3 mixed with Ultra Blazer increased necrosis injury as compared with Ultra Blazer alone. Roundup PowerMax3 alone did not cause necrosis injury to sugarbeet. Visual necrosis was most severe at Hendrum and Lake Lillian, MN.

Sugarbeet growth reduction from Ultra Blazer at 16 fl oz/A plus NIS ranged from 5% to 21% across locations (Table 4). Comparatively, sugarbeet growth reduction either increased, decreased, or remained the same, depending on location, from Ultra Blazer plus crop oil concentrate or from repeat applications of Ultra Blazer plus non-ionic surfactant, with no definitive pattern of growth reduction injury observed. However, sugarbeet growth was consistently reduced from Ultra Blazer plus Roundup PowerMax3 across all locations, regardless of adjuvant use.

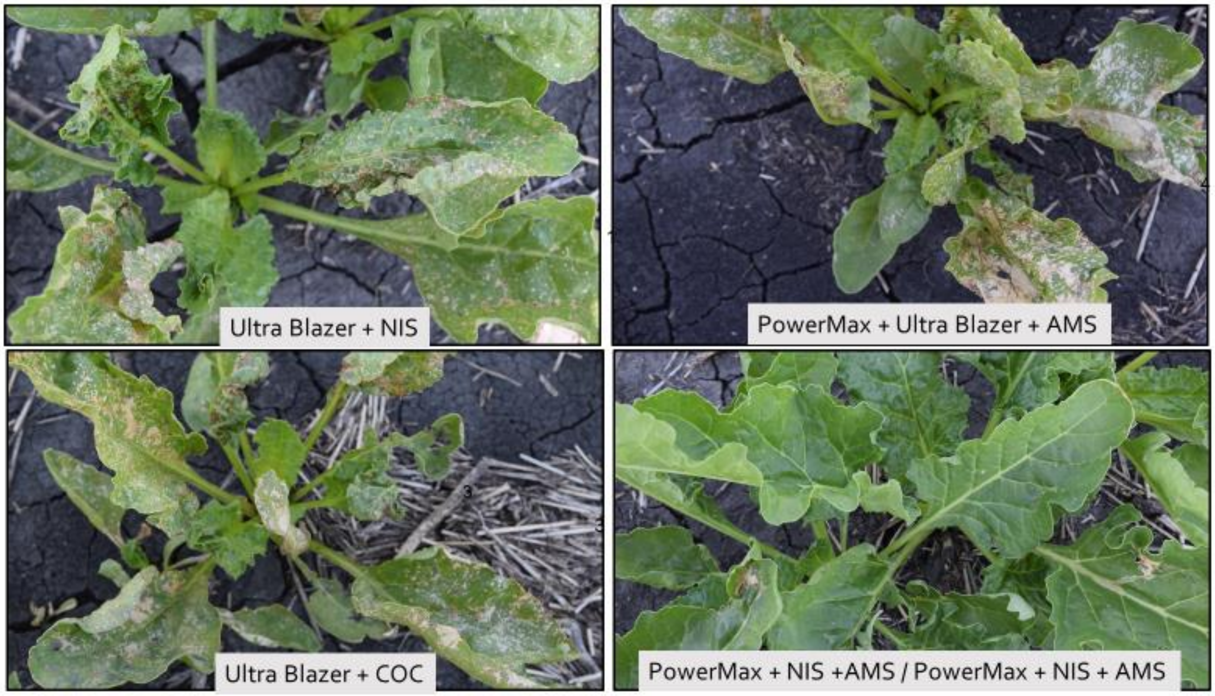

Figure 1. Sugarbeet necrosis injury symptoms in response to Ultra Blazer at 16 fl oz/A plus NIS or COC or mixed with Roundup PowerMax3 at 25 fl oz/A plus AMS as compared with repeat Roundup PowerMax3 at 25 fl oz/A plus NIS plus AMS, Hendrum, MN, 2022.

Table 4. Sugarbeet visible injury from herbicide treatments, across locations, 2022.[a]

Herbicide Treatment	Rate	Crookston Nec.[b]	Crookston GR	Hendrum Nec.	Hendrum GR	Murdock Nec.	Murdock GR	Lake Lillian Nec.	Lake Lillian GR
	----fl oz/A----	%							
Ultra Blazer + Prefer 90 NIS	16 + 0.25%	2 a	21 b	33 b	19 b	0 a	5 a	8 b	12 ab
Ultra Blazer + Prefer 90 NIS / Ultra Blazer + Prefer 90 NIS	12 + 0.125% / 12 + 0.125 %	24 b	17 ab	90 e	26 c	37 b	14 b	38 d	16 bc
Ultra Blazer + Crop oil concentrate	16 + 0.25%	2 a	14 a	46 c	29 c	2 a	13 b	8 b	12 ab
Roundup PowerMax3 + Ultra Blazer + Amsol Liquid AMS	25 + 16 + 2.5% v/v	5 a	32 c	58 d	42 d	2 a	21 c	18 c	23 c
Roundup PowerMax3 + Ultra Blazer + Prefer 90 NIS + Amsol Liquid AMS	25 + 16 + 0.25% + 2.5% v/v	5 a	29 c	50 c	38 d	2 a	25 c	23 c	13 abc
Roundup PowerMax3 Prefer 90 NIS + Amsol Liquid AMS / Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS	25 + 0.25% + 2.5% v/v / 25 + 0.25% + 2.5% v/v	0 a	12 a	0 a	5 a	0 a	0 a	0 a	4 a
LSD (0.10)		**5**	**6**	**8**	**7**	**3**	**6**	**6**	**10**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.
[b] Nec. = Visual necrosis and GR = growth reduction collected approximately 14 days after treatment (±3 days).

Sugarbeet injury from Ultra Blazer reduced sugarbeet stature (Figure 2). Stature reduction is greatest when Ultra Blazer is mixed with either oil-based adjuvants or herbicides and the air temperature is 85°F at or later in the day of application. However, sugarbeet rapidly recover from Ultra Blazer injury by producing new leaves (Figure 3).

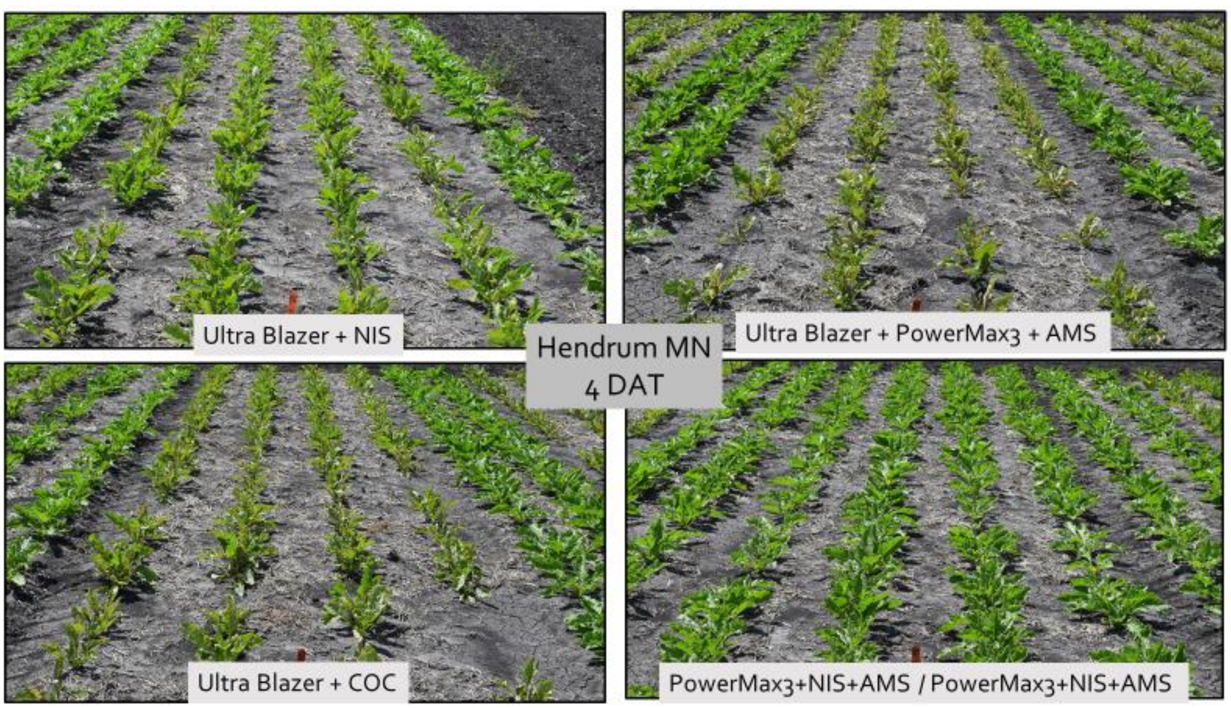

Figure 2. Sugarbeet injury in response to Ultra Blazer alone or mixed with Roundup PowerMax3 as compared with repeat Roundup PowerMax3 application, 4 DAT, Hendrum MN, 2022.

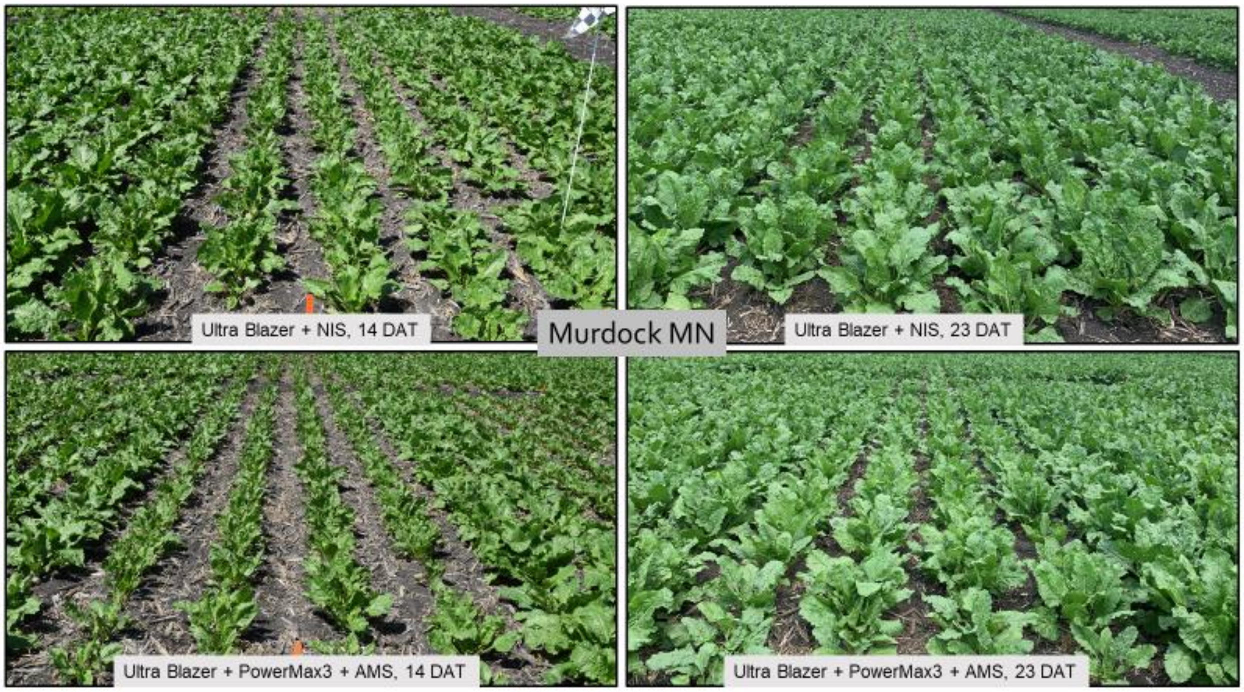

Figure 3. Sugarbeet regrowth following Ultra Blazer or Ultra Blazer mixtures with Roundup PowerMax3, Murdock, MN, 2022.

Not all yield parameters were significantly different at each individual location; however, we have elected to combine yield data and present differences across all locations in Table 5. Root yield and recoverable sucrose from a single application of Ultra Blazer plus NIS, Ultra Blazer plus COC, or repeat applications of Ultra Blazer plus NIS, generally were the same as the glyphosate control. Root yield and recoverable sucrose were less when Ultra Blazer was mixed with Roundup Powermax3 and Amsol or Amsol plus NIS. Ultra Blazer plus Roundup PowerMax3 consistently reduced root yield across locations compared with either product applied alone.

Table 5. Sugarbeet root yield, % sucrose, and recoverable sucrose in response to herbicide treatment across four locations, 2022.[a]

Herbicide Treatment	Rate	Root Yield	Sucrose	Recoverable Sucrose
	----------fl oz/A----------	-Ton/A-	--%--	---lb/A---
Ultra Blazer + Prefer 90 NIS	16 + 0.25%	31.0 b	16.0	8,504 abc
Ultra Blazer + Prefer 90 NIS / Ultra Blazer + Prefer 90 NIS	12 + 0.125% / 12 + 0.125 %	31.7 ab	16.1	8,770 a
Ultra Blazer + Crop oil concentrate	16 + 0.25%	31.4 ab	16.0	8,606 ab
Roundup PowerMax3 + Ultra Blazer + Amsol Liquid AMS	25 + 16 + 2.5% v/v	30.0 c	16.0	8,167 bc
Roundup PowerMax3 + Ultra Blazer + Prefer 90 NIS + Amsol Liquid AMS	25 + 16 + 0.25% + 2.5% v/v	29.4 c	16.0	7,974 c
Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS / Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS	25 + 0.25% + 2.5% v/v/ 25 + 0.25% + 2.5% v/v	32.8 a	16.1	8,963 a
P-Value (0.05)		**0.0040**	**NS**	**0.0123**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.

Roundup PowerMax3 contains the active ingredient glyphosate in the form of potassium salt at 5.88 pound per gallon as compared with potassium salt at 4.5 pounds per gallon in Roundup PowerMax. An increase in sugarbeet injury from Ultra Blazer mixtures with Roundup PowerMax was previously observed. However, we did not observe the magnitude of injury, nor did we observe loss in root yield and recoverable sucrose, from Ultra Blazer mixtures with Roundup Powermax (PowerMax vs. PowerMax3). Observations of increased phytotoxicity from Roundup PowerMax3 as compared with Roundup PowerMax tank mixed with other actives has been observed by other researchers (personal communication with Brett Miller, Syngenta).

Conclusion

The 2022 Ultra Blazer experiment was designed to determine if sugarbeet injury in response to Ultra Blazer could be reduced. Sugarbeet rapidly recovers from necrosis and growth reduction injury from Ultra Blazer plus NIS. The addition of COC with Ultra Blazer increases sugarbeet injury as compared with Ultra Blazer plus NIS; however, injury was less than Ultra Blazer mixtures with Roundup PowerMax3. A remedy to sugarbeet injury that may increase waterhemp control is applying split applications of Ultra Blazer at 12 fl oz/A plus NIS; however, we cannot avoid growth reduction or necrosis injury with split applications. Matter of fact, necrosis injury persists longer from repeat Ultra Blazer applications as compared with single applications; however, reduction in yield parameters did not occur. Ultra Blazer tank-mixtures with Roundup PowerMax3 and AMS or with AMS plus NIS caused significant sugarbeet injury that persisted and negatively impacted yield. We suggest utilizing single Ultra Blazer applications at 16 fl oz/A plus adjuvants or repeat applications of Ultra Blazer at 12 fl oz/A with NIS instead of Ultra Blazer mixtures with Roundup PowerMax3, unless there are significant waterhemp control challenges. Further research is needed to improve the tolerance of sugarbeet to these treatments in order to maintain yield parameters while optimizing waterhemp control.

ULTRA BLAZER SECTION 18 EMERGENCY EXEMPTION AND SUPPORTING EXPERIMENTS

Thomas Peters[1], Emma Burt[2], Alexa Lystad[3], and David Mettler[4]

[1]Extension Sugarbeet Agronomist and Weed Control Specialist, [2]Graduate Student and Research Agronomist, NDSU and Minn-Dak Farmers Cooperative, [3]Research Specialist, North Dakota State University & University of Minnesota, Fargo, ND, and [4]Research Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, MN

Summary

1. Ninety-three percent of respondents indicated the emergency exemption was beneficial for sugarbeet producers in Minnesota and North Dakota and contributed to overall weed management in 2022.
2. Eighty-nine percent of respondents indicated they would willingly support application for a 2023 emergency exemption in sugarbeet.
3. Roundup PowerMax3 mixed with Ultra Blazer reduced root yield as compared with repeat Roundup PowerMax3 applications or Ultra Blazer alone.
4. Apply Ultra Blazer at 20 gpa water carrier to optimize waterhemp control and/or use Turbo TeeJet Duo nozzles.

Introduction

The Environmental Protection Agency (EPA) approved our request for a Section 18 emergency exemption for Ultra Blazer (acifluorfen) which provided Minnesota and eastern North Dakota sugarbeet growers a postemergence herbicide to control glyphosate-resistant waterhemp in sugarbeet in 2022. The 2022 growing season was challenging for row crops producers, including sugarbeet producers, in Minnesota and North Dakota for several reasons. First, the calendar date for sugarbeet planting was delayed by cold and wet weather in April and early May. The average plant date was May 25, May 26, and May 19 for American Crystal Sugar Cooperative (ACS), Minn-Dak Farmers' Cooperative (MDFC), and Southern Minnesota Beet Sugar Cooperative (SMBSC) growers, respectively. Second, rainfall after planting to incorporate soil-residual herbicides commonly used for waterhemp control ranged from 1-inch to 5-inches below normal in June and July in the sugarbeet growing region south of Grand Forks, MN and into southwest and southcentral Minnesota. Lack of timely rainfall was widespread, especially in the SMBSC region. Finally, waterhemp emerging at or before sugarbeet emergence has historically caused the greatest loss of yield. Less than normal rainfall in April and May reduced the efficacy of preemergence (PRE), early postemergence (EPOST), and postemergence (POST) applied soil-residual herbicides. With the discontinuance of Betamix, there are currently no registered POST herbicides for effective waterhemp control that survives soil-residual herbicide treatments.

The exemption allowed a single Ultra Blazer application at 16 fluid ounces per acre per year. A Section 18 exemption under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes EPA to allow an unregistered use of a pesticide for a limited time if EPA determines that an emergency condition exists. This paper summarizes the Ultra Blazer Section 18 emergency exemption including application parameters and results of a survey of sugarbeet growers who applied Ultra Blazer. This report contains three 2022 program objectives: a) summarize results and user experiences from the 2022 Section 18 emergency exemption for use of Ultra Blazer in sugarbeet; b) summarize the crop tolerance experiment; and c) summarize the spray quality experiment.

Materials and Methods

Section 18 Emergency Exemption

Ultra Blazer was applied at 16 fl oz/A with non-ionic surfactant (NIS) or mixed with glyphosate and ammonium sulfate (AMS). One Ultra Blazer application was made per season using ground application equipment at 10 to 20 gpa water carrier targeting waterhemp less than 4-inches tall and sugarbeet greater than the 6-lf stage. Pre-harvest interval (PHI) was 45 days and Ultra Blazer was applied from April 28 through July 29, 2022.

Application of Ultra Blazer was targeted to air temperatures less than 85°F to reduce injury in sugarbeet. Likewise, producers were informed that sugarbeet injury may be greater following sudden changes from a cool, cloudy environment to a hot, sunny environment. On days when air temperature was greater than 85°F, we recommended delaying application until late afternoon or early evening or when air temperatures began to decrease.

Producers and agriculturalists at Southern Minnesota Beet Sugar Coop, Minn-Dak Farmers Coop, and American Crystal Sugar Coop were surveyed by electronic mail to learn about producer experiences with Ultra Blazer (Appendix).

Sugarbeet Tolerance

Experiments conducted near Crookston, Hendrum, Nashua, Lake Lillian, and Murdock, MN in 2022 evaluated sugarbeet tolerance from Ultra Blazer alone or mixed with glyphosate (Roundup PowerMax3). The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in 22-inch rows at about 62,000 seeds per acre with 4.6 inch spacing between seeds. Treatments shown in Table 1 were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length. Environmental conditions at application are in Table 2.

Table 1. Herbicide treatment, herbicide rate, and application timing across locations in 2022.

Herbicide Treatment	Rate (fl oz/A)	Application timing (SGBT leaf stage)
Ultra Blazer + Prefer 90 NIS	16 + 0.25%	6-8 lf
Ultra Blazer + Prefer 90 NIS / Ultra Blazer + Prefer 90 NIS	12 + 0.125% / 12 + 0.125 %	6-8 lf / A + 7-day
Ultra Blazer + Crop Oil Concentrate	16 + 0.25%	6-8 lf
Roundup PowerMax3 + Ultra Blazer + Amsol Liquid AMS	25 + 16 + 2.5% v/v	6-8 lf
Roundup PowerMax3 + Ultra Blazer + Prefer 90 NIS + Amsol Liquid AMS	25 + 16 + 0.25% + 2.5% v/v	6-8 lf
Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS / Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS	25 + 0.25% + 2.5% v/v / 25 + 0.25% + 2.5% v/v	2 lf / 6 lf

Table 2. Environmental application information.

	Crookston	Hendrum	Murdock	Lake Lillian
Date	June 24	July 5	June 22	June 22
Time of Day	10:00 AM	1:00 PM	6:00 AM	4:00 PM
Air Temperature (F)	80	73	-	84
Relative Humidity (%)	57	67	29	29
Wind Velocity (mph)	15	4	6	9
Wind Direction	NNW	NNE	NW	W
Soil Temp. (F at 6”)	70	-	74	-
Soil Moisture	Fair	Dry	Dry	Dry
Cloud Cover (%)	100	100	10	10

Visible sugarbeet necrosis, malformation, and growth reduction were evaluated approximately 7 and 14 days after treatment (DAT) as sugarbeet injury using a 0 to 100% injury scale with 0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stature. All evaluations were a visual estimate of injury in the four treated rows compared with the adjacent, two-row, untreated strip.

At harvest, sugarbeet was defoliated, harvested mechanically from the center two rows of each plot, and weighed. A root sample (about 20 lbs) was collected from each plot and analyzed for sucrose content and sugar loss to molasses by American Crystal Sugar Company (East Grand Forks, MN). Experimental design was a randomized complete block with six replications. Data were analyzed in this report as a RCBD with the ANOVA procedure of ARM, version 2022.5 software package.

Waterhemp Control as Influenced by Carrrier Volume and Nozzle Selection

Experiments conducted near Blomkest and Moorhead, MN and Hickson, ND in 2022 evaluated sugarbeet tolerance, waterhemp control, and spray coverage from Ultra Blazer mixed with crop oil concentrate. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in 22-inch rows at about 62,000 seeds per acre with 4.6 inch spacing between seeds. Treatments were applied with a bicycle sprayer in

15 or 20 gpa spray solution through various spray nozzles (Table 3) pressurized with CO_2 at 40 psi to the center four rows, of six row plots, 40 feet in length.

Table 3. Spray nozzles, nozzle size, spray pressure and resultant droplet size.

Nozzle	Size	Spray Pressure (psi)	Droplet Size
XR	XR 110002	40	F
AIXR	AIXR11002	40	C
Turbo TeeJet	TT11002	40	M
Turbo TeeJet Duo	2XTT11001	40	M

Water sensitive tape was attached to 12 tabs on a metal contraption and placed between rows three and four in rep 1 to simulate spray coverage to a 6-inch waterhemp plant. The contraption was removed from the plot after spraying and the water sensitive tape was transferred to a prepared template with coordinates matching the position on the contraption. The template was moved to a humidity-controlled environment for processing.

Figure 1. Water sensitive tape was attached to each tab on the contraption to simulate spray coverage on either sugarbeet or waterhemp.

Visible sugarbeet necrosis and growth reduction was evaluated approximately 7 and 14 DAT using a 0 to 100% injury scale with 0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stature. Visible waterhemp control using a 0 to 100 scale (0 is no injury and 100 is complete control) was evaluated approximately 7, 14, 28, and 42 days after application. All evaluations were a visual estimate of injury or control from the four treated rows compared with the adjacent, two-row, untreated strip. Data were analyzed in this report as a RCBD with the ANOVA procedure of ARM, version 2022.5 software package.

Results

According to a survey of sugarbeet growers and agriculturalists, Ultra Blazer at 16 fl oz/A was applied to 43,397 sugarbeet acres in 2022 (totaling 5,425 gallons of Ultra Blazer). Eighty-nine percent or 38,484 acres were applied in Minnesota and 11% or 4,913 acres were applied in North Dakota.

Three observations standout from overseeing the emergency exemption and summarizing observations and agriculturist/producer critiques. First, waterhemp escapes rob yield in a low growing crop like sugarbeet and our producers understand this and are motivated to take action. Waterhemp interferes with sugarbeet yield, but even worse, produces significant quantities of seed that must be managed for four to six years. Our producers understand Ultra Blazer is a tool we would prefer not to use. Second, Ultra Blazer consistently causes sugarbeet injury and waterhemp control is inconsistent (Figure 2). Waterhemp control is strongly influenced by environmental conditions at application and by spray quality or the selection of spray nozzles and carrier volume. Most growers are willing to accept the sugarbeet bronzing damage, provided waterhemp is controlled. It is becoming apparent that proper use of spray nozzles and selecting the appropriate carrier volume to ensure coverage improves the likelihood of success. Continued acifluorfen research must be focused on improving sugarbeet safety and waterhemp control. Finally, Roundup PowerMax3 mixed with Ultra Blazer caused more sugarbeet injury than was observed in the years Ms. Emma Burt conducted her research supporting her Masters of Science and in 2021, both in our producer fields and in our research. Our observations with Roundup PowerMax3 mixtures with Ultra Blazer will impact future recommendations.

Injury Scale:	
1	None (0-15%)
2	Slight (15-30%
3	Moderate (30-50%)
4	Severe (50-70%)

Control Scale:	
1	Excellent (90-99%)
2	Good (80-90%)
3	Fair (65-80%)
4	Poor (40-65%)

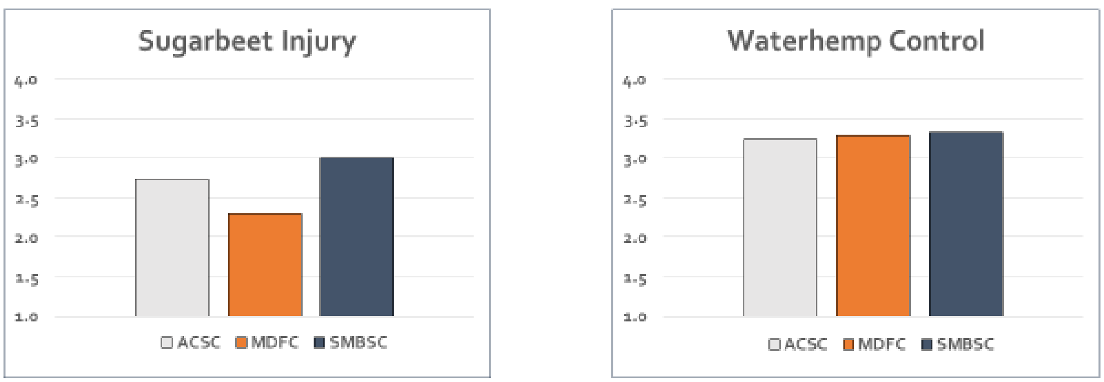

Figure 2. Results of producer and agriculturalist survey of sugarbeet injury and waterhemp control from Ultra Blazer Section 18 Emergency Exemption, Minnesota and North Dakota, 2022.

Sugarbeet Tolerance

Sugarbeet injury was evaluated multiple times throughout the growing season; however, only the evaluation of injury approximately 14 DAT is presented in Table 4. A very heavy rain event at Nashua, 6 days after planting, impacted sugarbeet stand and compromised the experimental area. We, therefore, elected to not present sugarbeet injury or yield data from Nashua, MN, due to variability.

Necrosis injury was evaluated as the percent of sugarbeet leaf area that was bronzed from Ultra Blazer application (Figure 3). Necrosis injury was greatest from repeat Ultra Blazer applications of 12 fl oz/A followed by (fb) 12 fl oz/A as compared with a single application of 16 fl oz/A and was consistent across locations (Table 4). Application of Roundup PowerMax3 mixed with Ultra Blazer increased necrosis injury as compared with Ultra Blazer alone. Roundup PowerMax3 alone did not cause necrosis injury to sugarbeet. Visual necrosis was most severe at Hendrum and Lake Lillian, MN.

Sugarbeet growth reduction from Ultra Blazer at 16 fl oz/A plus NIS ranged from 5% to 21% across locations (Table 4). Comparatively, sugarbeet growth reduction either increased, decreased, or remained the same, depending on location, from Ultra Blazer plus crop oil concentrate or from repeat applications of Ultra Blazer plus non-ionic surfactant, with no definitive pattern of growth reduction injury observed. However, sugarbeet growth was consistently reduced from Ultra Blazer plus Roundup PowerMax3 across all locations, regardless of adjuvant use.

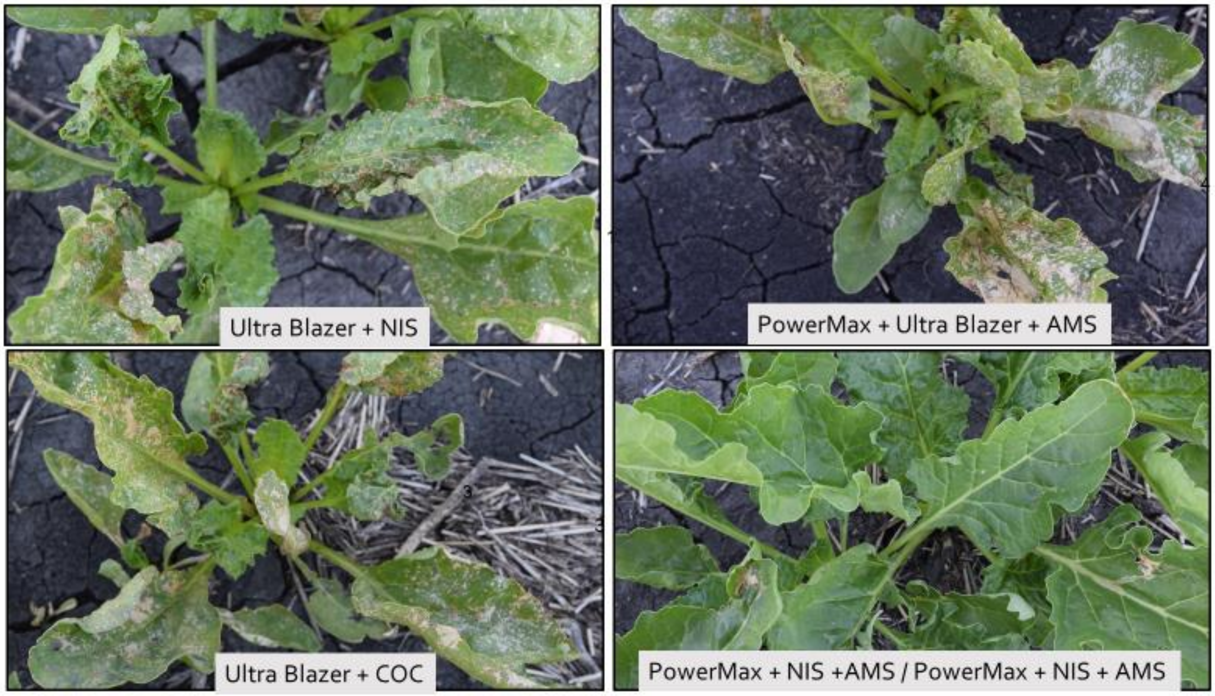

Figure 3. Sugarbeet necrosis injury symptoms in response to Ultra Blazer at 16 fl oz/A plus NIS or COC or mixed with Roundup PowerMax3 at 25 fl oz/A plus AMS as compared with repeat Roundup PowerMax3 at 25 fl oz/A plus NIS plus AMS, Hendrum, MN, 2022.

Table 4. Sugarbeet visible injury from herbicide treatments, across locations, 2022.[a]

		Sugarbeet Injury							
		Crookston		Hendrum		Murdock		Lake Lillian	
Herbicide Treatment	**Rate**	**Nec.[b]**	**GR**	**Nec.**	**GR**	**Nec.**	**GR**	**Nec.**	**GR**
	----fl oz/A----	---------------------------------%------------------------------------							
Ultra Blazer + Prefer 90 NIS	16 + 0.25%	2 a	21 b	33 b	19 b	0 a	5 a	8 b	12 ab
Ultra Blazer + Prefer 90 NIS / Ultra Blazer + Prefer 90 NIS	12 + 0.125% / 12 + 0.125 %	24 b	17 ab	90 e	26 c	37 b	14 b	38 d	16 bc
Ultra Blazer + Crop oil concentrate	16 + 0.25%	2 a	14 a	46 c	29 c	2 a	13 b	8 b	12 ab
Roundup PowerMax3 + Ultra Blazer + Amsol Liquid AMS	25 + 16 + 2.5% v/v	5 a	32 c	58 d	42 d	2 a	21 c	18 c	23 c
Roundup PowerMax3 + Ultra Blazer + Prefer 90 NIS + Amsol Liquid AMS	25 + 16 + 0.25% + 2.5% v/v	5 a	29 c	50 c	38 d	2 a	25 c	23 c	13 abc
Roundup PowerMax3 Prefer 90 NIS + Amsol Liquid AMS / Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS	25 + 0.25% + 2.5% v/v / 25 + 0.25% + 2.5% v/v	0 a	12 a	0 a	5 a	0 a	0 a	0 a	4 a
LSD (0.10)		**5**	**6**	**8**	**7**	**3**	**6**	**6**	**10**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.
[b] Nec. = Visual necrosis and GR = growth reduction collected approximately 14 days after treatment (±3 days).

Sugarbeet injury from Ultra Blazer reduced sugarbeet stature (Figure 4). Stature reduction is greatest when Ultra Blazer is mixed with either oil-based adjuvants or herbicides and the air temperature is 85°F at or later in the day of application. However, sugarbeet rapidly recover from Ultra Blazer injury by producing new leaves (Figure 5).

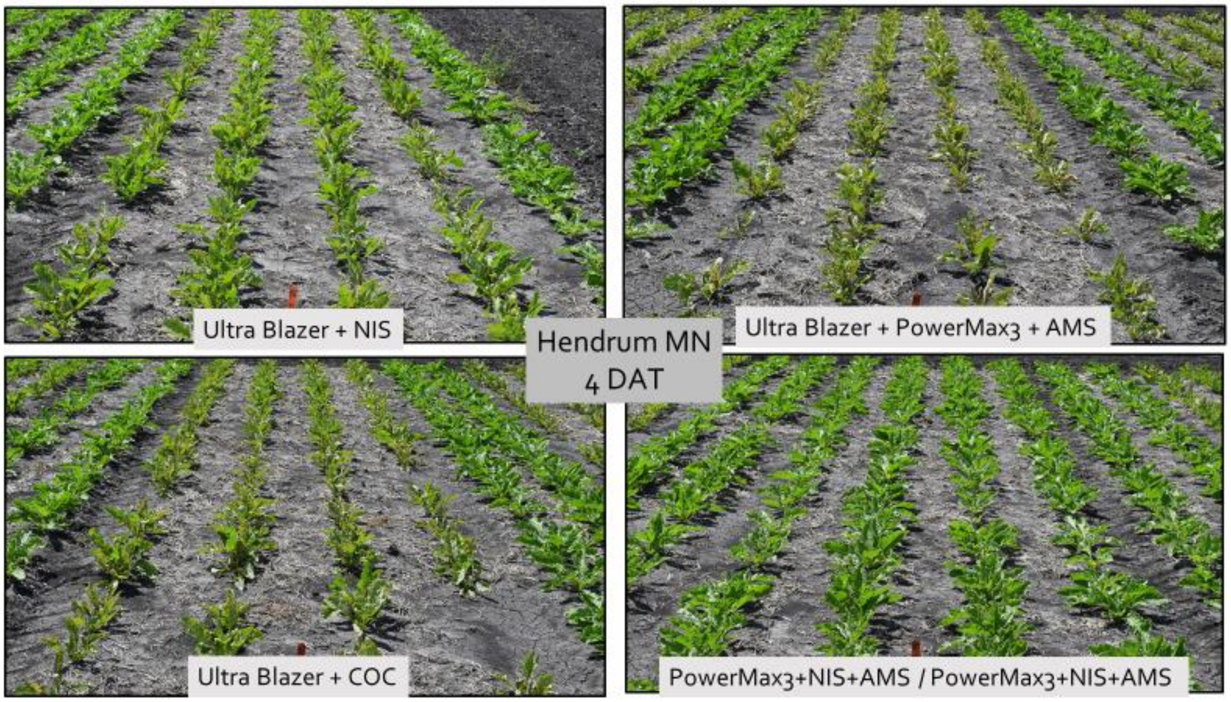

Figure 4. Sugarbeet injury in response to Ultra Blazer alone or mixed with Roundup PowerMax3 as compared with repeat Roundup PowerMax3 application, 4 DAT, Hendrum, MN, 2022.

Figure 5. Sugarbeet regrowth following Ultra Blazer or Ultra Blazer mixtures with Roundup PowerMax3, Murdock, MN, 2022.

Not all yield parameters were significantly different at each individual location; however, we have elected to combine yield data and present differences across all locations in Table 5. Root yield and recoverable sucrose from a single application of Ultra Blazer plus NIS, Ultra Blazer plus COC, or repeat applications of Ultra Blazer plus NIS, generally were the same as the glyphosate control. Root yield and recoverable sucrose were less when Ultra Blazer was mixed with Roundup Powermax3 and Amsol or Amsol plus NIS. Ultra Blazer plus Roundup PowerMax3 consistently reduced root yield across locations compared with either product applied alone.

Table 5. Sugarbeet root yield, % sucrose, and recoverable sucrose in response to herbicide treatment across four locations, 2022.[a]

Herbicide Treatment	Rate	Root Yield	Sucrose	Recoverable Sucrose
	----------fl oz/A----------	-Ton/A-	--%--	---lb/A---
Ultra Blazer + Prefer 90 NIS	16 + 0.25%	31.0 b	16.0	8,504 abc
Ultra Blazer + Prefer 90 NIS / Ultra Blazer + Prefer 90 NIS	12 + 0.125% / 12 + 0.125 %	31.7 ab	16.1	8,770 a
Ultra Blazer + Crop oil concentrate	16 + 0.25%	31.4 ab	16.0	8,606 ab
Roundup PowerMax3 + Ultra Blazer + Amsol Liquid AMS	25 + 16 + 2.5% v/v	30.0 c	16.0	8,167 bc
Roundup PowerMax3 + Ultra Blazer + Prefer 90 NIS + Amsol Liquid AMS	25 + 16 + 0.25% + 2.5% v/v	29.4 c	16.0	7,974 c
Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS / Roundup PowerMax3 + Prefer 90 NIS + Amsol Liquid AMS	25 + 0.25% + 2.5% v/v/ 25 + 0.25% + 2.5% v/v	32.8 a	16.1	8,963 a
P-Value (0.05)		**0.0040**	**NS**	**0.0123**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.

Roundup PowerMax3 contains the active ingredient glyphosate in the form of potassium salt at 5.88 pound per gallon as compared with potassium salt at 4.5 pounds per gallon in Roundup PowerMax. An increase in sugarbeet injury from Ultra Blazer mixtures with Roundup PowerMax was previously observed. However, we did not observe the magnitude of injury, nor did we observe loss in root yield and recoverable sucrose, from Ultra Blazer mixtures with Roundup Powermax (PowerMax vs. PowerMax3). Observations of increased phytotoxicity from Roundup PowerMax3 as compared with Roundup PowerMax tank mixed with other actives has been observed by other researchers (personal communication with Brett Miller, Syngenta).

Waterhemp Control as Influenced by Carrrier Volume and Nozzle Selection

Waterhemp infestation was erratic at Hickson, making application and evaluation difficult. Application was delayed and waterhemp size was larger than desired at Blomkest, due to challenges with excessive winds. Thus, we elected to prioritize the Moorhead location. We observed necrosis/bronzing on sugarbeet from Ultra Blazer by day three and by day eight, necrosis ranged from 43% to 58% at 15 gpa and ranged from 50% to 66% at 20 gpa (Table 6). However, spray nozzle or spray volume did not influence necrosis or growth reduction from Ultra Blazer.

Table 6. Sugarbeet injury in response to Ultra Blazer + COC applied through various nozzles at 15 and 20 gpa water carrier, Moorhead, MN, 2022.[a]

	Necrosis				**Growth Reduction**			
	15 GPA		**20 GPA**		**15 GPA**		**20 GPA**	
Nozzle	**8 DAT**	**12 DAT**	**8 DAT**	**12 DAT**	**8 DAT**	**12 DAT**	**8 DAT**	**12 DAT**
	-------%-------		-------%-------		-------%-------		-------%-------	
XR	58	33	50	38	6	19	11	20
AIXR	43	23	55	23	5	8	10	8
Turbo TeeJet	58	28	59	30	15	15	10	13
Turbo TeeJet Duo	58	26	66	43	10	10	16	19
LSD (0.10)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.

Waterhemp control from Ultra Blazer was influenced by spray nozzle and spray volume. In general, we observed greater waterhemp control when Ultra Blazer was applied through nozzles at 20 gpa as compared with 15 gpa (data not shown). Ultra Blazer through the Turbo TeeJet Duo consistently gave the best waterhemp control, presumably because it gave the best spray coverage over waterhemp (Table 7). Likewise, Ultra Blazer through AIXR nozzles consistently gave less waterhemp control.

Table 7. Waterhemp control in response to Ultra Blazer + COC applied through various nozzles, averaged across spray volume, Moorhead, MN, 2022.[a]

	Waterhemp control			
Nozzle	**8 DAT**	**12 DAT**	**28 DAT**	**42 DAT**
	---------------------------------------%	--		
XR	82	86 ab	70 b	60 b
AIXR	78	81 b	66 b	54 b
Turbo TeeJet	80	89 a	73 ab	59 b
Turbo TeeJet Duo	88	88 a	82 a	71 a
LSD (0.10)	**NS**	**6**	**9**	**11**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.

Conclusion

Controlling weeds in sugarbeet with pesticides continues to be a compromise between sugarbeet injury and weed control. For many years, producers had the luxury of broad-spectrum and uniform weed control with glyphosate and no sugarbeet injury. Glyphosate applied over RR sugarbeet continues to be the safest active ingredient I have evaluated in sugarbeet in my 36-year career, both as a graduate student working with sugarbeet, a representative of industry, and an academic, developing weed control strategies in sugarbeet. Sugarbeet are not affected by glyphosate rate, adjuvant, growth stage, or environmental conditions.

Glyphosate resistant (GR) weeds forces producers to pursue products that cause greater sugarbeet injury in pursuit of control of escaped weeds. The Section 18 emergency exemption exemplifies the need for Ultra Blazer in sugarbeet but also reveals the crop injury potential and the possibilities for waterhemp regrowth. I support the use of Ultra Blazer for control of weed escapes in sugarbeet. However, it is clear that we need to find ways to improve sugarbeet safety and optimize waterhemp control. Finally, we need to continue to pursue other options for control of GR weeds.

Appendix. Survey

2022 Ultra Blazer Section 18 Emergency Exemption
Field Observations

Please answer the following questions.

1. What county was Ultra Blazer used for weed control in sugarbeet?____________________

2. How many acres were sugarbeet treated with Ultra Blazer for weed control? ________________

3. Record sugarbeet injury (necrosis or growth reduction) from Ultra Blazer?

   None (0-15%)   Slight (15-30%)   Moderate (30-50%)   Severe (50-70%)

4. Record weed control from Ultra Blazer in sugarbeet?

   Excellent (90-99%)   Good (80-90%)   Fair (65-80%)   Poor (40-65%)

5. Did you observe any unexpected / adverse effects from using Ultra Blazer in sugarbeet?

   YES   NO

6. Did you find the Section 18 to be valuable/useful?

   YES   NO

7. Would you like to use Ultra Blazer again in 2023?

   YES   NO.

Write comments to provide additional details regarding your experiences.

____

____

____

WATERHEMP CONTROL FROM SOIL RESIDUAL PREEMERGENCE AND POSTEMERGENCE HERBICIDES IN 2022

Thomas J. Peters[1], Alexa L. Lystad[2], and David Mettler[3]

[1]Extension Sugarbeet Agronomist and Weed Control Specialist, [2]Research Specialist
North Dakota State University & University of Minnesota, Fargo, ND, and [3]Research Agronomist, Southern Minnesota Beet Sugar Cooperative, Renville, MN

Summary

1. Layering soil residual herbicides, beginning with preemergence (PRE) herbicide at planting, is our most effective strategy for controlling waterhemp in sugarbeet.
2. Differences in waterhemp control may occur, especially when rainfall is absent or not timely.
3. We do not completely understand the environmental conditions where ethofumesate fails to provide waterhemp control or why lack of control occurs.
4. Roundup PowerMax3 mixed with Ultra Blazer improved waterhemp control when soil residual herbicides failed due to lack of rainfall for activation.
5. Ultra Blazer mixed with Roundup PowerMax3 causes significant sugarbeet growth reduction injury which may cause loss of root yield compared with our soil residual waterhemp control standards, despite providing very good waterhemp control.

Introduction

Waterhemp control is our most important weed management challenge in sugarbeet according to the annual growers survey. Waterhemp is both common and troublesome in fields planted to sugarbeet for multiple reasons including full-season germination and emergence, prolific seed production, genetic diversity, and herbicide resistance. To date, waterhemp has shown resistance to herbicides from six classes, including Group 5 (e.g., triazines like atrazine), Group 2 (e.g., ALS-inhibiting herbicides like Pursuit), Group 14 (e.g., PPO-inhibiting herbicides like Ultra Blazer and Flexstar), Group 9 (e.g., glyphosate), Group 27 (e.g., HPPD-inhibiting herbicides like Callisto and Laudis), and Group 4 (e.g., 2,4-D).

The foundation of the waterhemp control program in sugarbeet is layered use of chloroacetamide (Group 15) herbicides PRE, early postemergence (EPOST), and POST, alone or in combination with glyphosate and ethofumesate, in sugarbeet (Figure 1). The goal is to have layered residual herbicides in the soil from planting through canopy closure, in late June or early July, to control waterhemp emergence.

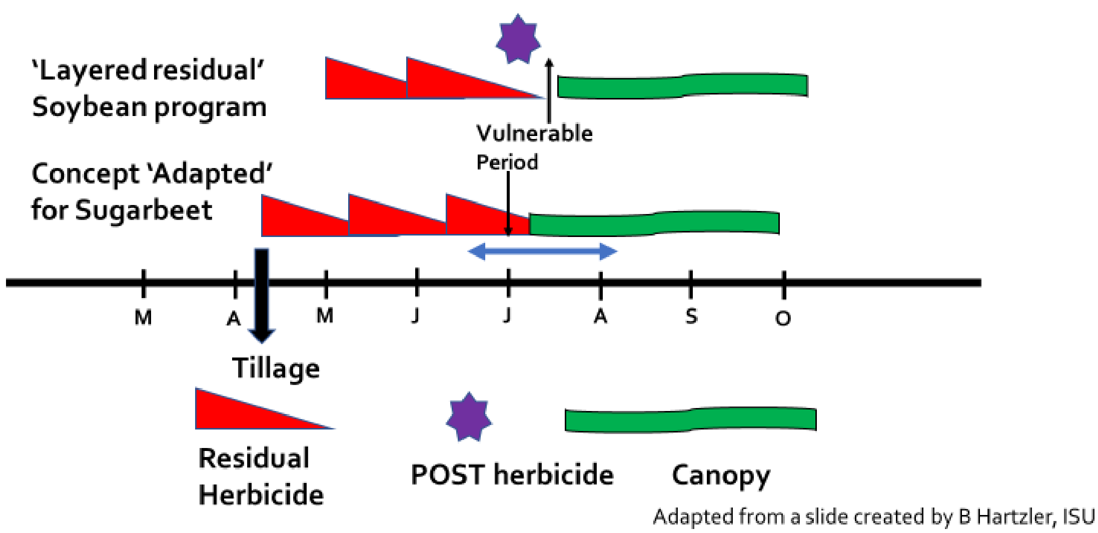

Figure 1. A demonstration of layered soil residual herbicides creating a herbicide barrier in soil from planting through canopy closure.

Calendar year 2022 created some unique challenges for sugarbeet growers. First, the spring was wet, resulting in average planting dates approximately 21 days later than the 20-year averages. Second, June and July rainfall were below normal in areas, compromising activation of soil residual herbicides (Figure 2).

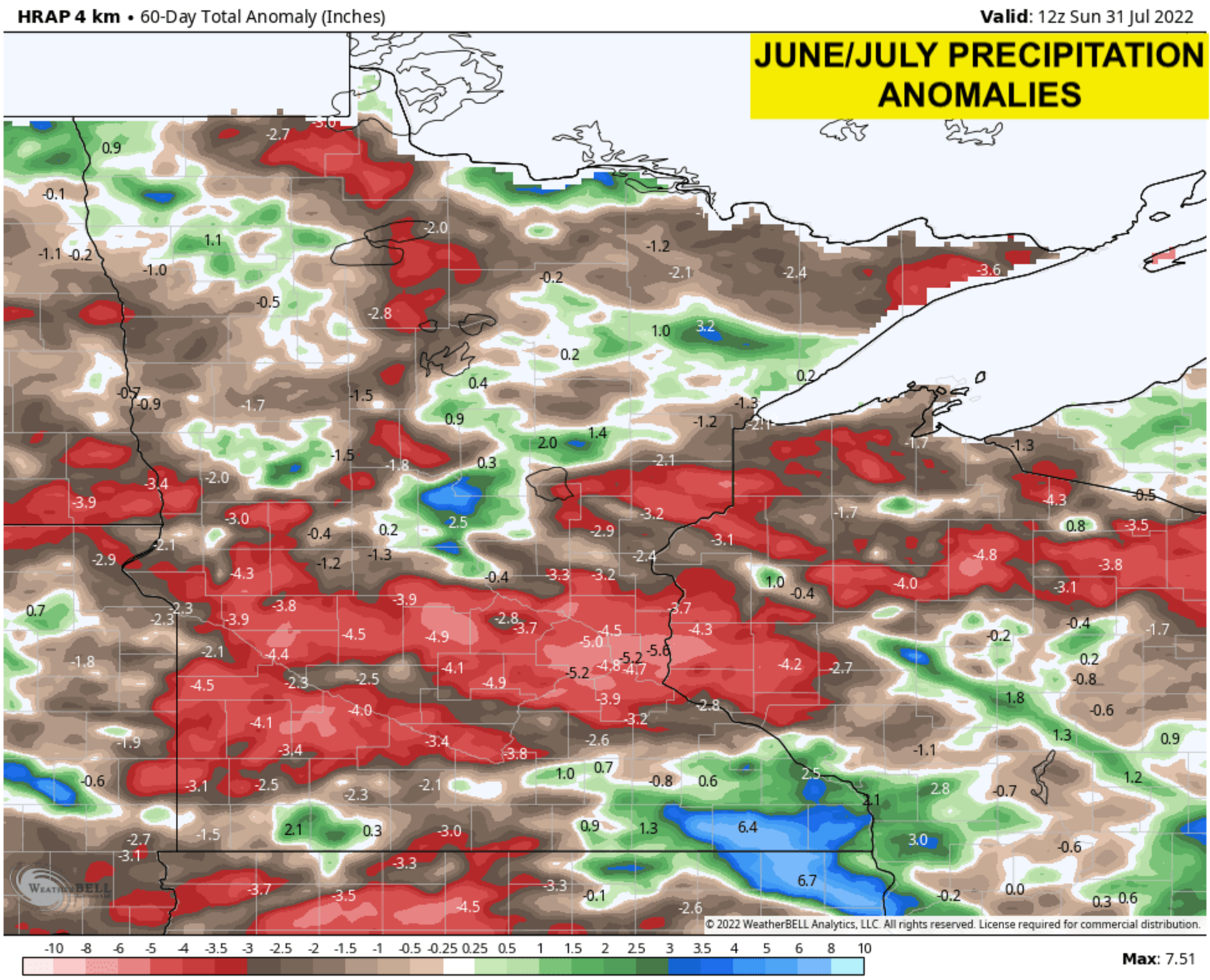

Figure 2. June and July, 2022 precipitation anomalies, Bring Me the News, Meteorologist Sven Sundgaard https://bringmethenews.com/minnesota-weather/july-2022-in-minnesota-was-hotter-windier-and-drier-than-normal.

The objectives of these experiments were 1) to demonstrate a weed control system for waterhemp control in sugarbeet, 2) to reinforce previous waterhemp control messages and practices for audiences with experience in waterhemp control, and 3) to examine differences in waterhemp control across experiments and investigate factors contributing to control.

Materials and Methods

Experiments were conducted near Blomkest, Moorhead, and Sabin, MN in 2022. Treatments are listed in Table 1. The experimental area was prepared for planting by fertilizing and conducting tillage across the experimental area. Sugarbeet was planted on May 27 at Blomkest, May 25 at Moorhead, and May 19 at Sabin in 2022. Sugarbeet was seeded in 22-inch rows at approximately 62,000 seeds per acre with 4.6 inch spacing between seeds. Treatments were applied with a bicycle sprayer in 17 gpa spray solution through XR8002 flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length.

Table 1. Herbicide treatment, rate, and application timing, Blomkest, Moorhead, and Sabin MN, 2022.

Herbicide Treatment PRE	Residual Herbicide Treatment POST[a]	Rate (fl oz/A)	Sugarbeet stage (lvs)
No	PowerMax3 + etho / PowerMax3 + Ultra Blazer[b]	25 + 6 / 25 + 16	2 / 6-8
No	Outlook / Outlook	12 / 12	2 / 6-8
No	Warrant / Warrant	48 / 48	2 / 6-8
No	Outlook / Warrant	12 / 48	2 / 6-8
No	Outlook / Warrant	12 / 64	2 / 6-8
Yes[c]	PowerMax3 + etho / PowerMax3 + Ultra Blazer	25 + 6 / 25 + 16	PRE/2 / 6-8
Yes	Outlook / Outlook	12 / 12	PRE/2 / 6-8
Yes	Warrant / Warrant	48 / 48	PRE/2 / 6-8
Yes	Outlook / Warrant	12 / 48	PRE/2 / 6-8
Yes	Outlook / Warrant	12 / 64	PRE/2 / 6-8

[a]Roundup PowerMax3 at 25 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC High Surfactant Methylated Oil Concentrate (HSMOC) at 1.5 pt/A and Amsol Liquid AMS at 2.5% v/v applied with every POST application that did not contain Ultra Blazer.
[b]Ultra Blazer applied with Roundup PowerMax 3 at 25 fl oz/A + Prefer 90 NIS at 0.25% v/v + Amsol Liquid AMS at 2.5% v/v.
[c]Ethofumesate + Dual Magnum at 2+0.5 pt/A PRE at Bloomkest and Sabin or ethofumesate at 6 pt/A PRE at Moorhead.

Visible sugarbeet growth reduction injury was evaluated using a 0 to 100% scale with 0% representing no visible injury and 100% as complete loss of plant / stand) approximately 7 and 14 days (+/- 3 days) following the 6-8 leaf application. Visible waterhemp control was evaluated using a 0 to 100% scale (0% indicating no control and 100% indicating complete weed control) and was collected 59, 90, and 94 days after planting. Experimental design was randomized complete block with four replications in a factorial treatment arrangement, factors being PRE and POST herbicide treatments. Data were analyzed with the ANOVA procedure of ARM, version 2022.5 software package.

At harvest, sugarbeet was defoliated and harvested mechanically from the center two rows of each plot and weighed at Moorhead and Sabin, MN. An approximate 30-pound sample was collected from each plot and analyzed for sucrose content and sugar loss to molasses by American Crystal Sugar Company (East Grand Forks, ND).

Results

Experiments at Blomkest and Moorhead, MN were planted later than average due to continuous spring rainfall in 2022. As a result, sugarbeet stands were variable at both locations. At Moorhead, experiments were planted into a cloddy seedbed. It was extremely dry at planting at Blomkest. In addition, excessively strong winds on June 21 partially defoliated sugarbeet. Timely rainfall events were measured at Moorhead in June and July following herbicide applications and in July at Sabin, MN; however, rainfall was much less at the Blomkest location (Table 2).

Table 2. Cumulative rainfall the first 10 days following herbicide application, across locations, 2022.

Herbicide Treatment	Moorhead, MN[a]	Sabin, MN	Blomkest, MN[b]
	------------------------------------	inch	------------------------------------
PRE Application	1.0	0.5	0.9
EPOST Application	1.7	0.4	0.0
POST Application	1.8	2.4	0.5
Total:	**4.5**	**3.3**	**1.4**

[a]Moorhead and Sabin precipitation data collected from nearby weather stations operated by North Dakota Agricultural Weather Network (NDAWN)
[b]Blomkest precipitation data collected using weather station instrumentation by Campbell Scientific.

Sugarbeet injury from soil residual herbicides ranged from 0% to 29% across evaluations and experiments (Table 3). Sugarbeet injury from soil residual herbicides tended to be greatest at Sabin and was less at Bloomkest and Moorhead. Assessment of sugarbeet injury at Bloomkest was complicated by erratic stands due to dry conditions and strong winds, which partially defoliated sugarbeet. At Sabin, sugarbeet injury from soil residual herbicides was observed 7 days after treatment (DAT) and remained visible 14 DAT, especially from PRE / EPOST / POST treatments.

Sugarbeet injury from Ultra Blazer + Roundup PowerMax3 POST ranged from 35% to 53% across locations and was greater than sugarbeet injury from soil residual herbicides POST (Table 3). Applying ethofumesate or ethofumesate + Dual Magnum PRE did not impact sugarbeet injury from Roundup PowerMax3 + ethofumesate followed by (fb) Roundup PowerMax3 + Ultra Blazer. Sugarbeet injury from Ultra Blazer declined numerically between the first and second evaluation.

Table 3. Sugarbeet visible injury in response to PRE and POST treatment, across locations, 2022.[a]

Herbicide Treatment PRE[c]	Herbicide Treatment POST[d]	Rate	Sugarbeet Injury[b] Sabin, MN 7 DAT	Sabin, MN 17 DAT	Moorhead, MN 10 DAT	Moorhead, MN 15 DAT	Blomkest, MN 9 DAT	Blomkest, MN 18 DAT
		-fl oz/A-	%					
No	PowerMax3 + etho / PowerMax3 + Ultra Blazer[e]	25 + 6 / 25 + 16	44 d	38 d	50 c	34 b	53 b	46 b
No	Outlook / Outlook	12 / 12	11 a	4 a	0 a	0 a	0 a	6 a
No	Warrant / Warrant	48 / 48	9 a	0 a	0 a	3 a	0 a	11 a
No	Outlook / Warrant	12 / 48	29 c	14 bc	0 a	5 a	0 a	5 a
No	Outlook / Warrant	12 / 64	9 a	3 a	16 b	4 a	0 a	0 a
Yes	PowerMax3 + etho / PowerMax3 + Ultra Blazer	25 + 6 / 25 + 16	50 d	35 d	50 c	48 b	48 b	41 b
Yes	Outlook / Outlook	12 / 12	13 ab	8 ab	0 a	0 a	0 a	5 a
Yes	Warrant / Warrant	48 / 48	20 abc	20 c	11 b	5 a	0 a	3 a
Yes	Outlook / Warrant	12 / 48	24 bc	15 bc	0 a	5 a	0 a	4 a
Yes	Outlook / Warrant	12 / 64	19 abc	4 a	8 a	0 a	0 a	8 a
LSD (0.10)			**12**	**8**	**9**	**8**	**5**	**11**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.
[b]Sugarbeet injury evaluations were approximately 7 and 14 days after application C, Ultra Blazer.
[c]Ethofumesate + Dual Magnum PRE at 2 + 0.5 pt/A at Blomkest and Sabin. Ethofumesate PRE at 6 pt/A at Moorhead.
[d]Roundup PowerMax3 at 25 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC High Surfactant Methylated Oil Concentrate (HSMOC) at 1.5 pt/A and Amsol Liquid AMS at 2.5% v/v applied with every POST application that did not contain Ultra Blazer.
[e]Ultra Blazer applied with Roundup PowerMax 3 at 25 fl oz/A + Prefer 90 NIS at 0.25% v/v + Amsol Liquid AMS at 2.5% v/v.

Waterhemp (with some redroot pigweed) control ranged from 36% to 96% across treatments and locations (Table 4). The average control across all treatments was 52%, 93% and 95% for Blomkest, Moorhead and Sabin, respectively. At Sabin, repeat Warrant applications or Outlook fb Warrant tended to provide waterhemp control greater than repeat Outlook applications. Addition of ethofumesate mixtures with Dual Magnum PRE did not improve waterhemp control. Waterhemp control was greatest from Roundup PowerMax3 mixtures with soil residual herbicides at Sabin compared with other locations.

Waterhemp control from soil residual herbicides applied POST which contained Warrant, or Outlook followed by Warrant, provided similar waterhemp control at Moorhead and Sabin. PRE herbicides followed by POST herbicides tended to provide waterhemp control similar to POST treatments alone. The exception was at Moorhead where the absence of PRE herbicides resulted in reduced waterhemp control from repeat POST Outlook applications.

Ultra Blazer mixed with Roundup PowerMax3 following ethofumesate PRE provided or tended to provide waterhemp control similar to soil residual herbicides POST. However, control was less when Ultra Blazer and Roundup PowerMax3 were applied without PRE ethofumesate.

Table 4. Waterhemp control in response to PRE and POST treatment, across location, 2022.[a]

Etho or Etho+DM PRE[b]	Soil Residual Treatment POST[c]	Rate	Waterhemp Control Blomkest, MN 59 DAP[d]	Moorhead, MN 90 DAP	Sabin, MN 94 DAP
		--fl oz/A--	---%	---	---
No	PowerMax3 + etho / PowerMax3 + Ultra Blazer[e]	25 + 6 / 25 + 16	63 ab	63 c	84 c
No	Outlook / Outlook	12 / 12	36 e	89 b	97 ab
No	Warrant / Warrant	48 / 48	54 bc	99 a	98 ab
No	Outlook / Warrant	12 / 48	43 de	96 ab	98 ab
No	Outlook / Warrant	12 / 64	54 bc	99 a	99 a
Yes	PowerMax3 + etho / PowerMax3 + Ultra Blazer	25 + 6 / 25 + 16	71 a	98 a	90 bc
Yes	Outlook / Outlook	12 / 12	43 de	99 a	98 ab
Yes	Warrant / Warrant	48 / 48	49 cd	99 a	99 a
Yes	Outlook / Warrant	12 / 48	56 bc	93 ab	92 ab
Yes	Outlook / Warrant	12 / 64	49 cd	99 a	96 ab
LSD (0.10)			**9**	**9**	**9**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.
[b]Ethofumesate + Dual Magnum PRE at 2 + 0.5 pt/A at Blomkest and Sabin. Ethofumesate PRE at 6 pt/A PRE at Moorhead.
[c]Roundup PowerMax3 at 25 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC High Surfactant Methylated Oil Concentrate (HSMOC) at 1.5 pt/A and Amsol Liquid AMS at 2.5% v/v applied with every POST application that did not contain Ultra Blazer.
[d]DAP=Days after plant
[e]Ultra Blazer applied with Roundup PowerMax3 at 25 fl oz/A + Prefer 90 NIS at 0.25% v/v + Amsol Liquid AMS at 2.5% v/v.

Waterhemp control from PRE herbicides were inconsistent and unacceptable at Blomkest, MN. We credit trial inconsistency to variable weed pressure across the experiment due to dry conditions in June. An on-site rainfall collection device recorded 0.79 inches of rainfall May 30 or three days after PRE application (Table 5). This rainfall event should have been sufficient to activate ethofumesate and Dual Magnum PRE. However, sub-optimal weed control was observed on June 21 (data not included in this report) contributing to the overall lack of control, even from PRE herbicides at Blomkest. We believe the lack of early season waterhemp control from the PRE herbicides contributed to the lack of POST control from glyphosate, ethofumesate and soil residual herbicides.

Table 5. Hourly rainfall measurements, May 30, 2022, near Blomkest, MN.[a]

Hour	Rainfall (inch)
Midnight to 5:00AM	0.00
5:00AM to 7:00AM	0.04
8:00AM to 9:00AM	0.27
9:00AM to 10:00AM	0.17
10:00AM to noon	0.10
1:00PM to 5:00PM	0.01
6:00PM to 7:00PM	0.18
7:00PM to 8:00PM	0.02
8:00PM to midnight	0.00

[a] Blomkest precipitation data collected using weather station instrumentation by Campbell Scientific.

Sabin was also very dry in early June. However, in contrast to Blomkest, we do not believe there was waterhemp seed germination and emergence throughout May and the first half of June at Sabin, MN. We did have sufficient moisture for sugarbeet emergence and observed uniform stands. Soil residual herbicides were activated by late June and July rainfall, resulting in excellent weed control. We are unsure if the PRE herbicide treatment was activated at Sabin; however, the POST herbicide treatments delivered effective control as compared with the control strips imbedded in the experiment.

Ultra Blazer mixed with Roundup PowerMax3 alone or following ethofumesate at 6 pt/A PRE reduced sugarbeet root yield and recoverable sucrose as compared with soil residual herbicides mixed with Roundup PowerMax3 (Table 6). Herbicide treatments did not affect % sucrose.

Ultra Blazer was mixed with Roundup PowerMax3 in 2022. Roundup PowerMax3 was a new glyphosate formulation, containing 5.88 pounds of glyphosate per gallon as compared with 4.6 pounds of glyphosate per gallon in Roundup PowerMax. The experiments did not contain either the Roundup PowerMax3 alone treatment or Roundup PowerMax plus Ultra Blazer treatment.

Table 6. Root yield, % sucrose and recoverable sucrose in response to herbicide treatment, Moorhead MN, 2022.[a]

Etho PRE[b]	Soil Residual Treatment POST[c]	Rate	Root Yield	Sucrose	Recoverable sucrose/A
		--fl oz/A--	---TPA[d]---	---%---	----lb/A----
No	PowerMax3 + etho / PowerMax3 + Ultra Blazer[e]	25 + 6 / 25 + 16	21.2 c	14.9	5,658 c
No	Outlook / Outlook	12 / 12	26.5 ab	15.1	7,147 ab
No	Warrant / Warrant	48 / 48	27.5 a	14.7	6,900 ab
No	Outlook / Warrant	12 / 48	29.1 a	15	7,838 a
No	Outlook / Warrant	12 / 64	28.4 a	15.2	7,237 ab
Yes	PowerMax3 + etho / PowerMax3 + Ultra Blazer	25 + 6 / 25 + 16	24.0 b	14.9	6,280 bc
Yes	Outlook / Outlook	12 / 12	26.8 a	15.1	7,236 ab
Yes	Warrant / Warrant	48 / 48	28.5 a	15.3	7,895 a
Yes	Outlook / Warrant	12 / 48	27.2 a	14.8	7,124 ab
Yes	Outlook / Warrant	12 / 64	28.1 a	15.1	7,683 a
LSD (0.10)			**2.7**	**NS**	**1,031**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 10% level of significance.
[b]Ethofumesate at 6 pt/A PRE applied at Moorhead.
[c]Roundup PowerMax3 at 25 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC High Surfactant Methylated Oil Concentrate (HSMOC) at 1.5 pt/A and Amsol Liquid AMS at 2.5% v/v applied with every POST application that did not contain Ultra Blazer.
[d]TPA=Tons per acre.
[e]Ultra Blazer applied with Roundup PowerMax3 at 25 fl oz/A + Prefer 90 NIS at 0.25% v/v + Amsol Liquid AMS at 2.5% v/v.

Our best research practices are not to harvest weed control experiments. In this situation, however, we felt that quantifying yield from sugarbeet treated with Ultra Blazer in a waterhemp rich environment would enable us to demonstrate that weed control from Ultra Blazer might off-set sugarbeet injury.

Conclusion

Rainfall is critical for achieving satisfactory waterhemp control from soil residual herbicides. Evaluating the impact of moisture on herbicide activity was not the primary objective for the experiment, but the observations around the relationship of moisture and herbicide activity became an important benefit from the experiment, especially considering the lack of waterhemp control experienced by many growers in Southern Minnesota Beet Sugar Coop and Minn-Dak Farmers Coop in 2022. This research reinforces that a strategy to layer soil residual herbicides, starting at planting, is our best program for controlling waterhemp in sugarbeet. Finally, this research demonstrated excellent sugarbeet safety from the chloroacetamide herbicides, that the three chloroacetamide herbicides available in sugarbeet are equally effective at providing waterhemp control, and that the differences in waterhemp control among chloroacetamide products are minor.

Appendix. Trials conducted in the SMBSC growing area but not reported in the 2022 Research Reports.

Trial	**Location**	**Description**
Nitrogen Fall/Spring Comparison	Renville	These trials were designed to compare nitrogen products and rates in a fall/spring design. Situations arose that made this data unusable.
Proprietary Products Trials	Renville	Four trials were conducted looking at a proprietary product that may have the ability to increase sugar content. This product is currently not labeled for use in sugar beets.
Crop Rotation Trial	Hector	2022 was only year one of a two-year trial. Data from this year will be included in the 2023 Research Report.
Weed Efficacy or Tolerance Trials	Blomkest, Murdock, and Renville	We conduct many weed control efficacy and tolerance trials with Dr. Tom Peters across the coop. Not all these trials are in this report as some may be proprietary or may be an incomplete data set.
Magno Prelim Trials	Wood Lake (2), Murdock, Hector, Lake Lillian, and Aph Nursery	These variety trials were conducted on behalf of the breeding company. The data is the property of the seed company, and the seed company contracts the research work by SMBSC. As such, no data was published on these trials.