2021

Research Report

Southern Minnesota Beet Sugar Cooperative

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Failure to acknowledge any form of assistance whether cooperative or technical is purely unintenional

Vision Statement:

Conduct industry leading agronomic and sugar beet storage research that enables Shareholder's data driven decisions to increase productivity and profitability and empowers the Cooperative's sustainability into the future.

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]
[1]*Production Agronomist, SMBSC, Renville, MN*

Introduction
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 production. 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.

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.

Materials and Methods
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 (4 locations * 6 replications per location). The experimental design of the trials was a partially balanced lattice design. 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. Seven Cercospora leaf spot fungicide applications were made at each of the OVT Yield Trial sites.

In early September, 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 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.

Three OVT-Disease Nurseries were planted near Renville for each Aphanomyces root rot (APH), Cercospora leaf spot (CLS), and Rhizoctonia root rot (RHC). Each of the nurseries is replicated by a third party. Cercospora leaf spot nurseries were conducted by SMBSC at a location near Renville and at a KWS location near

Randolph, MN. Aphanomyces root rot nurseries were conducted at KWS's facility in Shakopee, MN and in the SMBSC Aphanomyces nursery near Renville. Rhizoctonia 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 twice 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 CY22 Seed Approval. Data generated in CY21 was combined with the data generated from CY20 and CY19 trials for use in approving varieties for the CY22 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.

2021 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	Soybeans	No	4/20/2021	5/26/2021	10/7/2021	Light to moderate root rot and CLS
Yield	Steve and Nick Frank	Lake Lillian	Soybean	No	5/4/2021	6/10/2021	10/5/2021	Light CLS
Yield	Schwerin Farms	Wood Lake	Field Corn	No	5/24/2021	6/1/2021	9/27/2021	Generally disease free
Yield	Brett Petersen	Murdock	Field Corn	No	4/28/2021	6/2/2021	9/22/2021	Generally disease free

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 2021 APH Rating
Aphanomyces	KWS	Shakopee	KWS, M. Bloomquist, C. Groen, A. Chanda	50% of 2021 APH Rating
Cercospora	SMBSC	Renville	SMBSC Staff	50% of 2021 CLS Rating
Cercospora	KWS	Randolph	KWS Staff	50% of 2021 CLS Rating
Rhizoctonia	SMBSC	Renville	SMBSC Staff	50% of the 2021 RHC Rating
Rhizoctonia	BSDF - USDA/ARS	Michigan	Linda Hanson and USDA/ARS Staff	50% of the 2021 RHC Rating

Table 1. Comparison of 2022 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Three Years of Data (2019-2021)

		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*	
	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	
2022 Fully Approved Varieties - Three Years of Data (% of Mean is of Fully Approved Mean)																						
Crystal M837		280.6	102.2	9839.4	99.2	16.5	102.0	91.0	99.9	35.4	97.4	4.4	101.9	4.0	100.5	4.7	122.1	76.7	99.7	103.2	100.5	M837
SV 881	RHC	273.4	99.6	9911.8	99.9	16.1	99.5	91.2	100.1	36.5	100.4	4.2	97.2	4.0	100.5	3.9	99.8	75.2	97.7	99.3	99.8	881
SV 883	RHC	271.9	99.0	9887.1	99.7	16.1	99.5	90.9	99.8	36.5	100.4	4.4	101.9	4.2	105.5	3.6	91.6	78.7	102.3	98.6	99.0	883
SV RR862	RHC	272.4	99.2	9867.0	99.5	16.1	99.5	91.2	100.1	36.4	100.2	4.4	101.9	3.7	93.0	3.5	91.0	77.4	100.6	99.3	99.5	862
SV RR863	RHC	274.4	99.9	10096.8	101.8	16.1	99.5	91.3	100.2	36.9	101.5	4.2	97.2	4.0	100.5	3.7	95.4	76.7	99.7	99.5	101.1	863
Mean of Fully Approved:		**274.5**	**100.0**	**9920.4**	**100.0**	**16.2**	**100.0**	**91.1**	**100.0**	**36.3**	**100.0**	**4.3**	**100.0**	**4.0**	**100.0**	**3.9**	**100.0**	**76.9**	**100.0**	**100.0**	**100.0**	**Mean**
2022 Specialty Approved Varieties - Three Years of Data (% of mean is of Fully Approved Mean)																						
Beta 9952	CLS + RHC	268.3	97.7	9338.3	94.1	15.9	98.3	91.0	99.9	35.0	96.3	4.2	97.2	2.9	72.9	3.0	76.8	73.7	95.8	96.7	93.1	9952
Beta 9986	CLS	266.6	97.1	10211.7	102.9	15.8	97.7	91.0	99.9	38.6	106.2	4.3	99.5	2.1	52.8	4.1	106.9	79.0	102.7	95.6	101.5	9986
Crystal M951	CLS	266.6	97.1	10495.4	105.8	15.8	97.7	91.0	99.9	39.5	108.7	4.6	106.5	2.3	57.8	4.5	117.1	77.4	100.6	95.6	103.9	M951
Crystal M977	RHC	272.6	99.3	10605.5	106.9	16.0	98.9	91.2	100.1	39.3	108.1	4.0	92.6	4.3	108.0	3.3	85.0	74.5	96.8	98.2	106.2	M977
Hilleshog 2219	RHC	278.3	101.4	9048.9	91.2	16.3	100.7	91.2	100.1	32.9	90.5	4.9	113.4	4.1	103.0	3.0	76.9	72.9	94.7	101.5	91.9	2219
Hilleshog 2327	RHC	272.9	99.4	10169.8	102.5	16.1	99.5	91.2	100.1	37.5	103.2	4.3	99.5	4.0	100.5	3.8	97.2	75.0	97.5	99.3	102.5	2327
SV 894	RHC	271.1	98.7	9948.6	100.3	16.0	98.9	91.1	100.0	36.9	101.5	4.5	104.2	4.3	108.0	3.6	92.4	76.4	99.3	98.0	99.5	894

*__Revenue per Ton__ and **Revenue per Acre** figures were produced using the payment calculation with factors released on Oct. 22, 2021 for the final 2021 crop payment.

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

Table 2. Comparison of 2022 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Two Years of Data (2020-2021)

		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*	
	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	
2022 Fully Approved Varieties - Two Years of Data (% of Mean is of Fully Approved Mean)																						
Crystal M837		273.6	101.3	10567.2	100.3	16.4	101.9	90.1	99.8	38.9	99.2	4.6	106.0	4.0	99.5	4.6	112.3	76.8	100.9	102.8	102.0	M837
SV 881	RHC	269.7	99.9	10497.9	99.7	16.1	100.0	90.3	100.0	39.2	100.0	4.1	94.5	4.1	102.0	4.2	102.4	72.9	95.8	100.0	100.0	881
SV 883	RHC	268.1	99.3	10528.8	100.0	16.0	99.4	90.1	99.8	39.4	100.5	4.4	101.4	4.3	107.0	3.8	94.3	79.6	104.6	98.4	98.9	883
SV RR862	RHC	267.6	99.1	10437.1	99.1	15.9	98.8	90.5	100.2	39.2	100.0	4.4	101.4	3.6	89.6	3.8	94.8	75.6	99.3	98.3	98.3	862
SV RR863	RHC	270.8	100.3	10630.1	100.9	16.1	100.0	90.5	100.2	39.3	100.3	4.2	96.8	4.1	102.0	3.9	96.2	75.6	99.3	100.5	100.7	863
Mean of Fully Approved:		**270.0**	**100.0**	**10532.2**	**100.0**	**16.1**	**100.0**	**90.3**	**100.0**	**39.2**	**100.0**	**4.3**	**100.0**	**4.0**	**100.0**	**4.1**	**100.0**	**76.1**	**100.0**	**100.0**	**100.0**	**Mean**
2022 Test Market Varieties for Limited Sales - Two Years of Data (% of mean is of Fully Approved Mean)																						
Beta 9044		283.0	104.8	10807.0	102.6	16.8	104.3	90.6	100.3	38.5	98.2	4.6	106.0	4.2	104.5	4.0	98.9	77.9	102.4	108.5	106.6	9044
Beta 9088		280.6	103.9	10806.4	102.6	16.7	103.7	90.4	100.1	38.8	99.0	4.5	103.7	4.2	104.5	4.0	99.7	74.7	98.2	106.9	105.8	9088
Crystal M028		279.0	103.3	10810.4	102.6	16.5	102.5	90.7	100.4	39.0	99.5	4.3	99.1	4.0	99.5	4.1	100.7	77.2	101.4	105.4	104.9	M028
Crystal M089	CLS	263.8	97.7	10857.1	103.1	15.8	98.1	90.0	99.7	41.5	105.9	4.3	99.1	2.6	64.7	3.7	91.7	78.0	102.5	95.9	101.6	M089
Hilleshog 2379		268.7	99.5	10420.0	98.9	16.0	99.4	90.3	100.0	38.9	99.2	4.2	96.8	4.3	107.0	4.2	104.6	76.8	100.9	98.9	98.1	2379
2022 Specialty Approved Varieties - Two Years of Data (% of mean is of Fully Approved Mean)																						
Beta 9952	RHC + CLS	262.3	97.2	9892.7	93.9	15.7	97.5	90.2	99.9	37.9	96.7	4.2	96.8	2.8	69.7	3.3	81.8	72.5	95.3	95.3	92.2	9952
Beta 9986	CLS	259.8	96.2	10843.4	103.0	15.6	96.9	90.0	99.7	42.0	107.1	4.4	101.4	2.3	57.2	4.1	101.5	77.1	101.3	93.7	100.4	9986
Beta 9098	CLS	271.6	100.6	11048.0	104.9	16.2	100.6	90.3	100.0	40.9	104.3	4.9	112.9	2.5	62.2	4.6	113.2	74.4	97.8	101.1	105.5	9098
Crystal M951	CLS	262.1	97.1	10986.2	104.3	15.7	97.5	89.9	99.6	42.0	107.1	4.7	108.3	2.6	64.7	4.4	108.8	75.9	99.7	94.6	101.4	M951
Crystal M977	RHC	265.1	98.2	11228.9	106.6	15.9	98.8	90.1	99.8	42.7	108.9	4.1	94.5	4.4	109.5	3.7	91.1	73.6	96.7	97.3	106.0	M977
Crystal M002	CLS	269.2	99.7	10943.1	103.9	16.1	100.0	90.1	99.8	40.9	104.3	4.5	103.7	2.0	49.8	4.4	109.0	76.5	100.5	99.5	103.8	M002
Hilleshog 2219	RHC	271.7	100.6	9812.2	93.2	16.2	100.6	90.3	100.0	36.4	92.9	4.9	112.9	4.2	104.5	3.2	78.2	73.6	96.7	101.1	93.9	2219
Hilleshog 2327	RHC	268.1	99.3	10665.9	101.3	16.0	99.4	90.2	99.9	40.1	102.3	4.1	94.5	4.1	102.0	3.9	96.3	73.7	96.8	98.6	100.9	2327
SV 894	RHC	266.5	98.7	10494.5	99.6	15.9	98.8	90.3	100.0	39.6	101.0	4.6	106.0	4.4	109.5	3.9	95.5	75.9	99.7	97.8	98.8	894

*__Revenue per Ton__ and __Revenue per Acre__ figures were produced using the payment calculation with factors released on Oct. 22, 2021 for the final 2021 crop payment.

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

Table 3. Comparison of 2022 Fully Approved Varieties to Test Market and Specialty Approved Varieties - 1 Year Data (2021)

		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*	
	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	
2022 Fully Approved Varieties - One Year of Data (% of Mean is of Fully Approved Mean)																						
Crystal M837		262.0	101.6	11160.8	101.0	15.7	101.6	90.1	99.9	42.7	99.6	4.8	112.7	4.0	100.5	4.4	113.8	76.1	102.2	102.6	102.2	M837
SV 881	RHC	258.6	100.3	11132.8	100.8	15.5	100.3	90.2	100.0	43.1	100.6	3.9	91.5	4.0	100.5	4.0	103.5	69.6	93.5	100.4	101.0	881
SV 883	RHC	255.8	99.2	11127.2	100.7	15.4	99.6	90.0	99.8	43.5	101.5	4.6	108.0	4.2	105.5	3.6	91.8	78.1	104.9	98.7	100.2	883
SV RR862	RHC	253.9	98.4	10636.1	96.3	15.2	98.3	90.3	100.1	41.9	97.8	4.2	98.6	3.6	90.5	3.7	95.3	76.8	103.2	97.1	94.9	862
SV RR863	RHC	259.3	100.5	11180.6	101.2	15.5	100.3	90.5	100.3	43.1	100.6	3.8	89.2	4.1	103.0	3.7	95.6	71.6	96.2	101.2	101.8	863
Mean of Fully Approved:		**257.9**	**100.0**	**11047.5**	**100.0**	**15.5**	**100.0**	**90.2**	**100.0**	**42.9**	**100.0**	**4.3**	**100.0**	**4.0**	**100.0**	**3.9**	**100.0**	**74.4**	**100.0**	**100.0**	**100.0**	**Mean**
2022 Test Market Varieties - One Year of Data (% of mean is of Fully Approved Mean)																						
Beta 9044		271.3	105.2	11455.0	103.7	16.1	104.1	90.7	100.5	42.3	98.7	5.1	119.7	4.1	103.0	3.9	101.4	76.4	102.6	108.9	107.5	9044
Beta 9088		265.2	102.8	11401.1	103.2	15.9	102.8	90.2	100.0	43.1	100.6	4.8	112.7	4.1	103.0	4.0	102.9	71.9	96.6	105.2	105.8	9088
Crystal M028		266.3	103.2	11268.6	102.0	15.8	102.2	90.6	100.4	42.4	98.9	4.4	103.3	3.9	98.0	4.1	112.1	77.9	104.6	105.0	103.9	M028
Crystal M089	CLS	251.4	97.5	11497.4	104.1	15.2	98.3	89.9	99.6	45.8	106.9	4.2	98.6	2.5	62.8	3.5	105.0	76.9	103.3	96.1	102.7	M089
Hilleshog 2379		257.4	99.8	10830.3	98.0	15.4	99.6	90.3	100.1	42.0	98.0	4.3	100.9	4.1	103.0	4.3	110.7	76.0	102.1	99.5	97.5	2379
2022 Specialty Approved Varieties - One Year of Data (% of mean is of Fully Approved Mean)																						
Beta 9952	RHC + CLS	250.5	97.1	10315.3	93.4	15.1	97.7	90.0	99.8	41.3	96.4	4.4	103.3	2.8	70.4	3.2	83.5	70.5	94.7	95.2	91.7	9952
Beta 9986	CLS	247.3	95.9	11489.0	104.0	14.9	96.4	89.8	99.5	46.7	109.0	4.5	105.6	2.2	55.3	3.9	101.7	73.2	98.3	92.3	100.5	9986
Beta 9098	CLS	259.6	100.7	11676.3	105.7	15.5	100.3	90.4	100.2	44.8	104.5	4.9	115.0	2.3	57.8	4.8	123.5	72.2	97.0	100.9	105.5	9098
Crystal M951	CLS	252.8	98.0	11451.6	103.7	15.2	98.3	89.9	99.6	45.4	105.9	4.2	98.6	2.7	67.8	4.2	109.2	75.1	100.9	96.1	101.8	M951
Crystal M977	RHC	251.8	97.6	11943.2	108.1	15.3	99.0	89.4	99.1	47.5	110.8	4.2	98.6	4.3	108.0	3.6	92.7	70.0	94.0	96.0	106.4	M977
Crystal M002	CLS	257.3	99.8	11563.5	104.7	15.5	100.3	90.0	99.8	45.0	105.0	4.9	115.0	1.8	45.2	4.4	112.1	72.7	97.7	99.9	104.9	M002
Hilleshog 2219	RHC	252.7	98.0	10232.7	92.6	15.1	97.7	90.2	100.0	40.3	94.0	5.1	119.7	4.3	108.0	2.8	73.4	74.2	99.7	95.6	89.9	2219
Hilleshog 2327	RHC	254.1	98.5	11173.5	101.1	15.3	99.0	89.8	99.5	44.1	102.9	4.1	96.2	4.0	100.5	3.7	95.8	72.3	97.1	97.0	99.8	2327
SV 894	RHC	256.2	99.3	10955.7	99.2	15.4	99.6	90.2	100.0	42.9	100.1	4.7	110.3	4.4	110.6	3.8	96.7	74.7	100.3	99.2	99.3	894

*__Revenue per Ton__ and __Revenue per Acre__ figures were produced using the payment calculation with factors released on Oct. 22, 2021 for the final 2021 crop payment.

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

2019-2021 Disease Nursery Data for Aphanomyces, Cercospora, and Rhizoctonia

	Aphanomyces Root Ratings					Cercospora Leafspot Ratings					Rhizoctonia Root Ratings				
Variety Description	2021 Root Rating	2020 Root Rating	2019 Root Rating	**2020-2021** 2 Year Mean Root Rating	**2019-2021** 3 Year Mean Root Rating	2021 CLS Rating	2020 CLS Rating	2019 CLS Rating	**2020-2021** 2 Year Mean Foliar Rating	**2019-2021** 3 Year Mean Foliar Rating	2021 Root Rating	2020 Root Rating	2019 Root Rating	**2020-2021** 2 Year Mean Root Rating	**2019-2021** 3 Year Mean Root Rating
Fully Approved Varieties															
Crystal M837	4.8	4.4	3.9	4.6	4.4	4.0	4.0	3.9	4.0	4.0	4.4	4.7	5.1	4.6	4.7
SV 881 (RHC)	3.9	4.3	4.6	4.1	4.2	4.0	4.2	3.7	4.1	4.0	4.0	4.3	3.3	4.2	3.9
SV 883 (RHC)	4.6	4.3	4.5	4.4	4.4	4.2	4.3	4.0	4.3	4.2	3.6	4.1	3.0	3.8	3.6
SV RR862 (RHC)	4.2	4.6	4.5	4.4	4.4	3.6	3.7	3.8	3.6	3.7	3.7	4.0	2.9	3.8	3.5
SV RR863 (RHC)	3.8	4.5	4.3	4.2	4.2	4.1	4.1	3.7	4.1	4.0	3.7	4.1	3.3	3.9	3.7
Test Market Varieties															
Beta 9044	5.1	4.1		4.6		4.1	4.3		4.2		3.9	4.1		4.0	
Beta 9088	4.8	4.2		4.5		4.1	4.3		4.2		4.0	4.1		4.0	
Crystal M028	4.4	4.2		4.3		3.9	4.0		4.0		4.1	4.1		4.1	
Crystal M089 (CLS)	4.2	4.4		4.3		2.5	2.7		2.6		3.5	3.9		3.7	
Hilleshog 2379	4.3	4.2		4.2		4.1	4.5		4.3		4.3	4.2		4.2	
RHC Specialty Approved															
Beta 9952	4.4	4.1	4.2	4.2	4.2	2.8	2.8	3.0	2.8	2.9	3.2	3.4	2.3	3.3	3.0
Crystal M977	4.2	4.0	3.9	4.1	4.0	4.3	4.6	4.0	4.4	4.3	3.6	3.8	2.5	3.7	3.3
Hilleshog 2219	5.1	4.8	4.8	4.9	4.9	4.3	4.2	3.9	4.2	4.1	2.8	3.5	2.6	3.2	3.0
Hilleshog 2327	4.1	4.2	4.7	4.1	4.3	4.0	4.2	3.8	4.1	4.0	3.7	4.1	3.5	3.9	3.8
SV 894	4.7	4.6	4.3	4.6	4.5	4.4	4.4	4.0	4.4	4.3	3.8	4.0	3.0	3.9	3.6
CLS Specialty Approved															
Beta 9952	4.4	4.1	4.2	4.2	4.2	2.8	2.8	3.0	2.8	2.9	3.2	3.4	2.3	3.3	3.0
Beta 9986	4.5	4.3	4.0	4.4	4.3	2.2	2.3	1.8	2.3	2.1	3.9	4.3	4.2	4.1	4.1
Beta 9098	4.9	4.9		4.9		2.3	2.7		2.5		4.8	4.4		4.6	
Crystal M951	4.2	5.2	4.6	4.7	4.6	2.7	2.4	1.9	2.6	2.3	4.2	4.6	4.8	4.4	4.5
Crystal M002	4.9	4.1		4.5		1.8	2.1		2.0		4.4	4.5		4.4	
Crystal M089	4.2	4.4		4.3		2.5	2.7		2.6		3.5	3.9		3.7	
	Aphanomyces Ratings from SMBSC Nursery at Renville and KWS Nursery in Shakopee. **Ratings are on scale of 1 - 9.**					Cercospora Ratings from SMBSC Nursery in Renville and KWS Nursery near Randolph MN. **Ratings are on scale of 1-9.**					Rhizoctonia Ratings from SMBSC Nursery at Renville and BSDF Nursery in Michigan **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 9098	212	16.0	90.8	37.1	9974.3	98.6%
Crystal M977	209	16.2	90.3	40.1	10933.9	107.8%
Crystal M002	207	16.1	90.7	38.2	10401.8	103.3%
Hilleshog 2327	201	16.0	90.1	37.0	9923.0	97.3%
SV 863	197	16.2	90.2	36.1	9758.6	96.5%
SV 894	204	16.0	90.4	36.5	9805.2	96.5%
Mean	205	16.1	90.4	37.5	10132.8	100.0
%CV	4	2.1	0.6	3.4	4.2	5.8
PR>F	0.0168	0.8484	0.4071	<0.0001	<0.0001	0.0043
LSD (0.05)	8			1.4	466.8	6.4
Reps	7	7	7	7	7	7

Combined data from 7 locations with each location considered a replicate.
Locations: Redwood Falls, Willmar, Raymond, Maynard, Benson, and Bird Island Early and Late.
Revenue is calculated using the 2020 crop payment calculator, utilizing values released Oct. 22, 2021

SMBSC Variety Strip Trial - Redwood Falls

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9098	176	177.5	16.8	90.3	281.7	10347	96.4%	Beta 9098
Crystal M977	162	163.8	16.7	90.3	279.8	11861	110.0%	Crystal M977
Crystal M002	169	170.0	16.7	90.5	281.9	10864	101.2%	Crystal M002
Hilleshog 2327	168	170.0	17.0	90.2	284.8	10527	98.7%	Hilleshog 2327
SV 863	169	170.0	17.0	90.5	286.0	10220	96.1%	SV 863
SV 894	171	172.5	16.6	90.1	277.4	10586	97.6%	SV 894
Average	**169**	**16.8**	**90.3**	**38.1**	**281.9**	**10734**	**100.0%**	**Average**

Planted: April 21, 2021

Harvested: October 16, 2021

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 9098	200	16.6	89.1	49.4	273.9	13520	103.9%	Beta 9098
Crystal M977	196	16.5	90.5	48.9	278.8	13630	105.9%	Crystal M977
Crystal M002	188	16.1	89.1	45.4	265.7	12062	90.8%	Crystal M002
Hilleshog 2327	192	16.4	89.9	47.1	272.9	12858	98.6%	Hilleshog 2327
SV 863	176	16.7	90.2	48.2	280.9	13530	105.7%	SV 863
SV 894	186	16.2	90.0	48.7	271.1	13194	100.7%	SV 894
Beta 9780	174	16.5	89.6	43.5	274.5	11952	92.0%	Beta 9780
Beta 9986	190	16.7	90.4	46.9	280.3	13139	102.5%	Beta 9986
Average	**188**	**16.5**	**89.9**	**47.3**	**274.8**	**12986**	**100.0%**	**Average**

Planted: April 22, 2021

Harvested: October 14, 2021

Agriculturalist: Jared Kelm

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

SMBSC Variety Strip Trial - Willmar

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9098	218	15.0	91.6	39.1	255.7	9992	102.7%	Beta 9098
Crystal M977	222	14.9	92.1	43.1	254.3	10970	112.2%	Crystal M977
Crystal M002	218	15.2	92.1	42.6	259.7	11063	115.0%	Crystal M002
Hilleshog 2327	210	14.8	91.9	36.9	252.2	9303	94.6%	Hilleshog 2327
SV 863	202	14.5	90.3	37.7	241.9	9123	89.7%	SV 863
SV 894	204	13.9	91.3	38.5	233.5	9001	85.9%	SV 894
Average	**212**	**14.7**	**91.5**	**39.7**	**249.6**	**9909**	**100.0%**	**Average**

Planted: April 24, 2021

Harvested: September 24, 2021

Agriculturalist: Jared Kelm

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 9098	236	14.4	89.4	35.3	237.2	8381.2	94.7%	Beta 9098
Crystal M977	214	15.0	87.7	39.2	240.7	9446.9	108.1%	Crystal M977
Crystal M002	214	14.9	89.0	36.9	242.9	8957.2	103.3%	Crystal M002
Hilleshog 2327	214	14.4	87.8	36.7	231.1	8486.8	93.7%	Hilleshog 2327
SV 863	211	14.6	88.8	36.1	238.4	8596.5	97.5%	SV 863
SV 894	228	15.0	88.8	35.9	245.7	8823.8	102.7%	SV 894
Average	**219**	**14.7**	**88.6**	**36.7**	**239.3**	**8782.1**	**100.0%**	**Average**

Planted: April 29, 2021
Harvested: September 15, 2021
Agriculturalist: Bill Luepke

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 9098	205	17.0	90.4	31.8	286.2	9098.9	100.0%	Beta 9098
Crystal M977	210	16.7	91.3	35.9	284.9	10221.4	112.1%	Crystal M977
Crystal M002	196	17.1	91.2	33.3	291.9	9708.3	108.0%	Crystal M002
Hilleshog 2327	194	16.6	89.4	32.3	275.1	8880.2	95.2%	Hilleshog 2327
SV 863	184	16.7	90.1	30.5	280.0	8528.6	92.5%	SV 863
SV 894	211	17.0	90.6	29.2	286.6	8377.4	92.2%	SV 894
Average	**200**	**16.9**	**90.5**	**32.1**	**284.1**	**9135.8**	**100.0%**	**Average**

Planted: April 22, 2021
Harvested: October 6, 2021
Agriculturalist: Austin Neubauer

SMBSC Variety Strip Trial - Bird Island - Early

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9098	219	16.4	90.8	26.0	277.9	7230.4	105.0%	Beta 9098
Crystal M977	220	16.1	89.5	24.6	267.1	6568.1	92.9%	Crystal M977
Crystal M002	219	15.6	90.1	27.1	259.7	7028.3	97.4%	Crystal M002
Hilleshog 2327	199	15.8	90.1	26.7	264.1	7056.9	99.0%	Hilleshog 2327
SV 863	200	16.8	90.5	25.5	282.1	7204.7	105.7%	SV 863
SV 894	208	16.3	90.2	25.5	273.0	6970.2	100.0%	SV 894
Average	**211**	**16.2**	**90.2**	**25.9**	**270.6**	**7009.8**	**100.0%**	**Average**

Planted: April 22, 2021
Harvested: August 25, 2021
Agriculturalist: Les Plumley

SMBSC Variety Strip Trial - Bird Island - Late

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9098	219	16.5	89.5	41.2	274.4	11309.0	96.0%	Beta 9098
Crystal M977	220	17.1	89.7	43.7	285.4	12464.3	108.5%	Crystal M977
Crystal M002	219	16.7	89.9	40.3	278.5	11212.1	96.1%	Crystal M002
Hilleshog 2327	199	17.1	90.7	40.3	289.9	11680.7	102.7%	Hilleshog 2327
SV 863	200	17.3	89.9	38.3	288.5	11047.2	96.8%	SV 863
SV 894	208	17.2	89.8	39.5	288.1	11385.9	99.7%	SV 894
Average	**211**	**17.0**	**89.9**	**40.5**	**284.1**	**11516.5**	**100.0%**	**Average**

Planted: April 22, 2021
Harvested: October 17, 2021
Agriculturalist: Les Plumley

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 9098	206	16.0	91.3	49.4	272.3	13461.2	95.4%	Beta 9098
Crystal M977	210	16.9	91.8	51.8	289.8	15005.0	110.7%	Crystal M977
Crystal M002	216	16.6	92.2	48.8	286.2	13979.6	102.3%	Crystal M002
Hilleshog 2327	221	16.4	90.9	48.8	277.2	13525.9	97.0%	Hilleshog 2327
SV 863	213	16.4	90.9	49.0	277.4	13589.8	97.5%	SV 863
SV 894	200	16.3	91.7	48.4	278.6	13492.1	97.1%	SV 894
Average	**211**	**16.4**	**91.5**	**49.4**	**280.3**	**13842.3**	**100.0%**	**Average**

Planted: May 1, 2021
Harvested: November 1, 2021
Agriculturalist: Scott Thaden

Hector OVT

		Sugar		PercentES		EST		TonsPerAcre		ESA		Purity		Emergence	
ID	Entry Name	Mean	% of mean	Mean	% of mean	Mean	% of mean	Mean	% of mean	Mean	% of mean	Mean	% of mean	Mean	% of mean
A	Baseline 12a Hilleshog 2327	15.29	99.3	12.86	99.7	257.24	99.7	46.34	101.9	11,922.7	101.6	90.77	100.3	76.37	103.7
B	Hilleshog 2397	14.88	96.6	12.20	94.5	243.89	94.5	44.23	97.2	10,807.5	92.1	89.15	98.6	68.63	93.2
C	SV 883	15.47	100.5	12.93	100.2	258.69	100.2	44.56	97.9	11,567.5	98.5	90.43	100.0	79.03	107.3
D	Crystal M977	15.17	98.5	12.61	97.7	252.15	97.7	50.76	111.6	12,730.5	108.4	89.89	99.4	70.40	95.6
E	Crystal M106	16.24	105.5	13.69	106.1	273.79	106.1	46.62	102.5	12,752.9	108.6	90.91	100.5	75.79	102.9
F	Beta 9952	15.04	97.6	12.63	97.8	252.57	97.9	43.06	94.7	10,991.7	93.6	90.72	100.3	71.78	97.5
G	Crystal M143	15.82	102.7	13.31	103.2	266.30	103.2	47.65	104.7	12,715.0	108.3	90.79	100.4	72.88	99.0
H	Filler #2	15.59	101.2	13.04	101.1	260.88	101.1	45.92	100.9	11,928.5	101.6	90.61	100.2	81.25	110.4
I	Beta 9088	15.86	103.0	13.29	103.0	265.75	103.0	45.60	100.2	12,178.0	103.7	90.35	99.9	70.94	96.4
J	Beta 9780	15.56	101.1	13.14	101.8	262.71	101.8	47.37	104.1	12,457.7	106.1	90.90	100.5	68.45	93.0
K	Beta 9131	15.67	101.8	13.01	100.8	260.17	100.8	46.70	102.7	12,162.7	103.6	89.77	99.2	78.07	106.0
L	Hilleshog 2327	15.24	99.0	12.67	98.2	253.41	98.2	47.17	103.7	11,933.6	101.6	89.99	99.5	69.86	94.9
M	Hilleshog 2396	15.11	98.1	12.52	97.0	250.33	97.0	43.67	96.0	10,958.5	93.3	89.85	99.3	68.65	93.2
N	SV 805	15.23	98.9	12.77	99.0	255.41	99.0	44.27	97.3	11,321.6	96.4	90.58	100.1	70.88	96.3
O	Beta 9103	15.79	102.5	13.37	103.6	267.42	103.6	43.88	96.5	11,650.5	99.2	91.17	100.8	70.19	95.3
P	SV 893	15.25	99.0	12.76	98.9	255.22	98.9	43.35	95.3	11,033.4	94.0	90.45	100.0	67.58	91.8
Q	Hilleshog 2399	15.43	100.2	12.87	99.8	257.44	99.7	46.15	101.4	11,888.6	101.3	89.83	99.3	76.14	103.4
R	Beta 9044	15.75	102.3	13.24	102.6	264.79	102.6	44.45	97.7	11,799.4	100.5	90.61	100.2	79.10	107.4
S	Crystal M837	15.57	101.1	13.01	100.8	260.21	100.8	46.08	101.3	11,987.4	102.1	90.25	99.8	79.16	107.5
T	Crystal M951	14.99	97.4	12.46	96.6	249.23	96.6	48.85	107.4	12,097.1	103.0	90.02	99.5	74.53	101.2
U	SV 819	15.23	98.9	12.92	100.1	258.31	100.1	44.53	97.9	11,593.7	98.8	91.44	101.1	76.57	104.0
V	Baseline 7a Hilleshog 4017RR	15.81	102.7	13.35	103.4	266.92	103.4	39.51	86.9	10,683.9	91.0	90.75	100.3	76.87	104.4
W	Baseline 8a Hilleshog 9093RR	15.03	97.6	12.57	97.4	251.38	97.4	43.23	95.0	10,728.2	91.4	90.42	100.0	72.51	98.5
X	Crystal M002	15.09	98.0	12.58	97.5	251.50	97.4	48.48	106.6	12,197.9	103.9	90.22	99.7	70.58	95.9
Y	Filler #4	15.46	100.4	13.35	103.4	267.02	103.5	44.26	97.3	11,919.4	101.5	90.82	100.4	74.37	101.0
Z	Filler #1	15.84	102.9	13.43	104.1	268.66	104.1	43.82	96.3	11,677.8	99.5	91.08	100.7	71.12	96.6
AA	Baseline 9a SV RR863	15.19	98.6	12.61	97.7	252.22	97.7	42.55	93.5	10,701.3	91.2	90.00	99.5	66.27	90.0
AB	Hilleshog 2219	15.12	98.2	12.64	97.9	252.70	97.9	43.55	95.7	11,150.6	95.0	90.30	99.8	75.54	102.6
AC	Filler #3	15.13	98.2	12.54	97.2	250.80	97.2	46.79	102.9	11,722.4	99.8	89.78	99.2	75.97	103.2
AD	Hilleshog 2398	15.49	100.6	13.05	101.1	260.95	101.1	44.29	97.4	11,573.0	98.6	90.89	100.5	73.89	100.4
AE	SV 817	15.08	98.0	12.44	96.4	248.86	96.4	42.23	92.8	10,469.6	89.2	89.52	99.0	69.94	95.0
AF	SV 881	15.37	99.8	12.83	99.4	256.52	99.4	45.96	101.0	11,819.1	100.7	90.12	99.6	66.55	90.4
AG	Baseline 10a Crystal M623	15.27	99.2	12.75	98.8	254.91	98.8	45.65	100.3	11,556.6	98.4	90.20	99.7	77.18	104.8
AH	Baseline 11a Beta 9780	15.57	101.1	13.07	101.3	261.44	101.3	46.33	101.9	12,184.4	103.8	90.59	100.1	75.72	102.8
AI	SV 894	15.06	97.8	12.67	98.2	253.38	98.2	43.12	94.8	10,854.6	92.5	90.87	100.4	71.68	97.4
AJ	Hilleshog 2379	15.39	99.9	12.83	99.4	256.64	99.4	43.60	95.8	11,194.9	95.4	90.09	99.6	71.85	97.6
AK	SV RR862	14.98	97.3	12.58	97.5	251.54	97.5	43.49	95.6	10,909.9	92.9	90.75	100.3	72.78	98.9
AL	Crystal M115	16.04	104.2	13.48	104.5	269.62	104.5	44.34	97.5	11,904.3	101.4	90.54	100.1	75.15	102.1
AM	SV 818	15.09	98.0	12.59	97.6	251.89	97.6	43.17	94.9	10,797.1	92.0	90.16	99.7	71.21	96.7
AN	Beta 9098	15.46	100.4	13.04	101.0	260.64	101.0	47.79	105.0	12,475.8	106.3	90.95	100.5	73.53	99.9
AO	Crystal M168	15.63	101.5	13.17	102.1	263.46	102.1	46.99	103.3	12,391.8	105.5	90.77	100.3	72.74	98.8
AP	Beta 9124	15.86	103.0	13.29	102.9	265.64	102.9	47.81	105.1	12,772.0	108.8	90.53	100.1	80.90	109.9
AQ	Crystal M089	15.16	98.4	12.64	98.0	252.87	98.0	49.87	109.6	12,582.6	107.2	90.26	99.8	77.77	105.6
AR	Beta 9986	14.94	97.0	12.40	96.1	247.95	96.1	49.91	109.7	12,334.5	105.1	89.90	99.4	72.75	98.8
AS	SV RR863	15.11	98.2	12.55	97.2	250.98	97.2	46.20	101.5	11,630.6	99.1	90.01	99.5	72.90	99.0
AT	Hilleshog 2395	15.05	97.8	12.67	98.2	253.31	98.1	46.11	101.4	11,660.9	99.3	90.74	100.3	72.97	99.1
AU	Crystal M028	15.75	102.3	13.47	104.4	269.42	104.4	46.68	102.6	12,616.7	107.5	91.87	101.6	83.02	112.8
AV	Beta 9810	16.09	104.5	13.83	107.2	276.66	107.2	42.83	94.1	11,850.9	100.9	92.29	102.0	72.26	98.2
AW	Beta 9155	15.30	99.4	12.63	97.9	252.70	97.9	49.28	108.3	12,433.5	105.9	89.59	99.0	73.30	99.6
Average		15.40	100.0	12.90	100.0	258.09	100.0	45.49	100.0	11,740.3	100.0	90.46	100.0	73.62	100.0
Residual		0.15		0.20		78.60		2.37		325,119.3		1.47		44.41	
%CV		2.53		3.43		3.44		3.38		4.86		1.34		9.05	
LSD (0.05)		0.44		0.50		10.03		1.74		645.23		1.37		7.54	

Lake Lillian OVT

		Sugar		PercentEs		EST		TonsPerAcre		ESA		Purity		Emergence	
ID	Entry Name	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean
A	Baseline 12a Hilleshog 2327	16.00	99.9	13.57	100.9	271.32	100.9	42.66	105.0	11,600.4	106.3	91.09	100.7	72.39	102.6
B	Hilleshog 2397	15.86	99.0	13.25	98.5	265.04	98.5	41.50	102.1	10,984.2	100.6	90.10	99.6	69.37	98.3
C	SV 883	16.07	100.3	13.58	101.0	271.50	100.9	42.18	103.8	11,418.7	104.6	90.87	100.4	73.50	104.1
D	Crystal M977	15.64	97.7	12.93	96.1	258.55	96.1	44.08	108.5	11,385.7	104.3	89.54	99.0	66.06	93.6
E	Crystal M106	16.00	99.9	13.43	99.9	268.69	99.9	40.96	100.8	11,038.0	101.1	90.48	100.0	73.78	104.5
F	Beta 9952	15.71	98.1	13.16	97.8	263.17	97.8	39.02	96.0	10,179.2	93.3	90.29	99.8	58.97	83.5
G	Crystal M143	16.26	101.5	13.65	101.5	273.00	101.5	41.28	101.6	11,234.9	102.9	90.45	100.0	71.71	101.6
H	Filler #2	16.40	102.4	13.80	102.6	275.93	102.6	36.30	89.3	10,024.7	91.8	90.56	100.1	72.90	103.3
I	Beta 9088	16.32	101.9	13.72	102.1	274.46	102.0	40.57	99.9	11,155.0	102.2	90.56	100.1	72.33	102.5
J	Beta 9780	16.12	100.6	13.64	101.4	272.86	101.5	41.38	101.8	11,357.8	104.0	90.92	100.5	65.13	92.3
K	Beta 9131	16.10	100.5	13.37	99.4	267.45	99.4	42.07	103.5	11,299.6	103.5	90.86	100.4	69.37	98.3
L	Hilleshog 2327	15.99	99.8	13.31	98.9	266.12	98.9	41.14	101.2	10,877.1	99.6	89.85	99.3	67.18	95.2
M	Hilleshog 2396	16.31	101.8	13.81	102.7	276.20	102.7	39.30	96.7	10,805.6	99.0	90.85	100.4	69.50	98.4
N	SV 805	16.04	100.1	13.50	100.4	270.08	100.4	41.06	101.1	11,081.8	101.5	90.65	100.2	73.98	104.8
O	Beta 9103	16.61	103.7	13.93	103.6	278.71	103.6	39.68	97.7	11,093.3	101.6	90.16	99.7	62.86	89.0
P	SV 893	15.65	97.7	13.01	96.8	260.20	96.7	39.65	97.6	10,319.0	94.5	89.70	99.1	64.86	91.9
Q	Hilleshog 2399	15.48	96.6	12.97	96.4	259.29	96.4	41.49	102.1	10,773.5	98.7	90.45	100.0	71.50	101.3
R	Beta 9044	16.63	103.8	14.09	104.8	281.81	104.8	40.23	99.0	11,150.1	102.1	90.93	100.5	72.77	103.1
S	Crystal M837	16.37	102.2	13.81	102.7	276.20	102.7	39.67	97.6	10,954.4	100.4	90.68	100.2	75.57	107.1
T	Crystal M951	15.87	99.1	13.30	98.9	265.93	98.9	41.16	101.3	10,998.9	100.8	90.34	99.9	77.74	110.1
U	SV 819	15.86	99.0	13.45	100.0	269.06	100.0	40.32	99.2	10,807.5	99.0	91.28	100.9	67.89	96.2
V	Baseline 7a Hilleshog 4017RR	15.81	98.7	13.23	98.4	264.59	98.4	34.97	86.1	9,161.6	83.9	90.21	99.7	73.85	104.6
W	Baseline 8a Hilleshog 9093RR	15.63	97.6	12.99	96.6	259.84	96.6	39.18	96.4	10,201.3	93.5	89.89	99.4	66.13	93.7
X	Crystal M002	16.12	100.6	13.43	99.9	268.54	99.8	41.12	101.2	11,032.7	101.1	89.89	99.4	73.38	103.9
Y	Filler #4	16.03	100.1	13.35	99.3	266.96	99.3	41.04	101.0	10,952.2	100.3	89.80	99.3	70.16	99.4
Z	Filler #1	16.75	104.6	14.20	105.6	284.00	105.6	39.58	97.4	11,215.7	102.7	90.92	100.5	67.80	96.0
AA	Baseline 9a SV RR863	15.68	97.9	13.15	97.8	262.96	97.8	40.62	100.0	10,680.8	97.8	90.51	100.0	69.93	99.1
AB	Hilleshog 2219	15.18	94.7	12.67	94.2	253.34	94.2	37.70	92.8	9,549.7	87.5	90.06	99.5	68.38	96.9
AC	Filler #3	16.15	100.8	13.63	101.3	272.57	101.3	41.83	102.9	11,438.8	104.8	90.67	100.2	74.89	106.1
AD	Hilleshog 2398	15.95	99.6	13.47	100.1	269.33	100.1	40.13	98.8	10,844.6	99.3	90.69	100.2	67.74	96.0
AE	SV 817	15.79	98.6	13.36	99.4	267.32	99.4	40.89	100.6	10,877.5	99.6	91.02	100.6	70.80	100.3
AF	SV 881	15.90	99.2	13.30	98.9	265.92	98.9	40.61	99.9	10,858.9	99.5	90.20	99.7	68.41	96.9
AG	Baseline 10a Crystal M623	15.96	99.7	13.30	98.9	265.94	98.9	40.95	100.8	10,851.3	99.4	89.98	99.5	68.69	97.3
AH	Baseline 11a Beta 9780	16.08	100.4	13.42	99.8	268.42	99.8	41.22	101.5	11,056.0	101.3	90.16	99.7	76.29	108.1
AI	SV 894	16.05	100.2	13.26	98.6	265.13	98.6	41.36	101.8	10,929.4	100.1	89.31	98.7	72.16	102.2
AJ	Hilleshog 2379	15.91	99.3	13.33	99.1	266.50	99.1	41.22	101.4	10,987.5	100.7	90.37	99.9	73.24	103.7
AK	SV RR862	16.04	100.1	13.52	100.5	270.33	100.5	41.53	102.2	11,203.9	102.6	90.80	100.4	78.78	111.6
AL	Crystal M115	16.71	104.3	14.22	105.7	284.27	105.7	39.43	97.0	11,172.8	102.4	91.22	100.8	67.10	95.0
AM	SV 818	15.86	99.0	13.44	100.0	268.90	100.0	40.08	98.6	10,853.0	99.4	91.31	100.9	74.94	106.2
AN	Beta 9098	15.98	99.8	13.32	99.0	266.37	99.0	42.98	105.8	11,504.4	105.4	89.92	99.4	66.33	94.0
AO	Crystal M168	16.20	101.1	13.77	102.4	275.36	102.4	40.83	100.5	11,276.6	103.3	91.25	100.9	71.60	101.4
AP	Beta 9124	16.35	102.1	13.93	103.6	278.54	103.6	42.51	104.6	11,850.9	108.6	91.52	101.2	78.10	110.6
AQ	Crystal M089	15.49	96.7	12.84	95.5	256.69	95.4	41.17	101.3	10,549.6	96.6	89.87	99.3	72.86	103.2
AR	Beta 9986	15.34	95.8	12.78	95.0	255.54	95.0	43.29	106.5	10,993.0	100.7	90.14	99.6	70.72	100.2
AS	SV RR863	16.25	101.4	13.70	101.9	274.02	101.9	40.23	99.0	11,010.2	100.9	90.76	100.3	65.44	92.7
AT	Hilleshog 2395	15.95	99.6	13.35	99.3	267.08	99.3	41.66	102.5	11,062.9	101.3	90.32	99.8	69.66	98.7
AU	Crystal M028	16.12	100.6	13.53	100.6	270.51	100.6	39.35	96.8	10,597.3	97.1	90.49	100.0	73.70	104.4
AV	Beta 9810	16.37	102.2	13.77	102.4	275.34	102.4	37.51	92.3	10,338.8	94.7	90.50	100.0	66.87	94.7
AW	Beta 9155	15.95	99.6	13.45	100.0	269.03	100.0	42.31	104.1	11,294.0	103.5	90.79	100.4	71.66	101.5
Average		16.02	100.0	13.45	100.0	268.96	100.0	40.63	100.0	10,916.0	100.0	90.47	100.0	70.59	100.0
Residual		0.14		0.19		77.03		3.24		377,481.8		1.13		50.49	
%CV		2.03		2.82		2.82		3.74		4.95		0.96		9.00	
LSD (0.05)		0.42		0.50		9.93		2.04		695.25		1.20		8.04	

Wood Lake OVT

ID	Entry Name	Sugar Mean	Sugar % of Mean	PercentES Mean	PercentES % of Mean	EST Mean	EST % of Mean	TonsPerAcre Mean	TonsPerAcre % of Mean	ESA Mean	ESA % of Mean	Purity Mean	Purity % of Mean	Emergence Mean	Emergence % of Mean
A	Baseline 12a Hilleshog 2327	15.44	99.9	12.75	99.4	254.98	99.4	45.28	106.0	11,529.6	105.3	89.34	99.5	79.12	103.3
B	Hilleshog 2397	15.37	99.4	12.76	99.5	255.27	99.5	41.26	96.6	10,557.6	96.4	89.79	100.0	79.20	103.4
C	SV 883	15.25	98.7	12.46	97.2	249.16	97.2	42.61	99.7	10,666.1	97.4	88.81	99.0	79.84	104.3
D	Crystal M977	15.26	98.8	12.56	98.0	251.27	98.0	46.68	109.3	11,794.0	107.7	89.22	99.4	72.70	94.9
E	Crystal M106	15.75	101.9	13.11	102.3	262.25	102.3	45.29	106.0	11,999.5	109.6	89.90	100.2	80.52	105.2
F	Beta 9952	14.77	95.5	12.05	94.0	240.97	94.0	43.33	101.4	10,416.1	95.1	88.88	99.0	79.57	103.9
G	Crystal M143	15.17	98.2	12.40	96.7	248.06	96.7	44.24	103.6	10,897.0	99.5	88.98	99.1	74.91	97.8
H	Filler #2	15.70	101.6	13.11	102.2	262.19	102.2	39.58	92.6	10,345.9	94.5	89.94	100.2	75.42	98.5
I	Beta 9088	15.85	102.5	13.18	102.8	263.62	102.8	41.04	96.1	10,790.3	98.5	89.72	100.0	72.07	94.1
J	Beta 9780	15.25	98.7	12.45	97.1	249.04	97.1	44.19	103.4	11,034.6	100.8	88.65	98.8	71.83	93.8
K	Beta 9131	15.61	101.0	13.08	102.0	261.73	102.1	44.23	103.5	11,610.9	106.0	90.34	100.7	76.62	100.1
L	Hilleshog 2327	15.35	99.3	12.74	99.4	254.84	99.4	42.87	100.3	10,945.8	99.9	89.67	99.9	77.93	101.8
M	Hilleshog 2396	15.47	100.1	12.83	100.1	256.62	100.1	41.64	97.5	10,630.1	97.1	90.02	100.3	76.99	100.5
N	SV 805	14.94	96.7	12.29	95.8	245.82	95.9	43.34	101.5	10,579.4	96.6	89.24	99.4	76.21	99.5
O	Beta 9103	16.11	104.3	13.34	104.0	266.72	104.0	40.72	95.3	10,878.7	99.3	89.41	99.6	67.31	87.9
P	SV 893	15.03	97.3	12.29	95.8	245.78	95.8	41.93	98.2	10,365.5	94.6	89.20	99.4	74.60	97.4
Q	Hilleshog 2399	15.36	99.4	12.79	99.7	255.71	99.7	42.67	99.9	10,941.3	99.9	89.93	100.2	75.55	98.7
R	Beta 9044	16.00	103.5	13.36	104.2	267.19	104.2	41.43	97.0	11,129.9	101.6	90.14	100.4	75.71	98.9
S	Crystal M837	15.59	100.9	12.94	100.9	258.82	100.9	39.62	92.7	10,165.6	92.8	89.73	100.0	76.72	100.2
T	Crystal M951	15.50	100.3	12.91	100.6	258.08	100.6	44.80	104.9	11,510.9	105.1	89.95	100.2	73.33	95.8
U	SV 819	14.92	96.6	12.37	96.5	247.39	96.5	42.87	100.4	10,582.3	96.6	89.66	99.9	77.59	101.3
V	Baseline 7a Hilleshog 4017RR	15.43	99.9	12.76	99.5	255.27	99.5	38.73	90.7	9,858.9	90.0	89.80	100.1	74.64	97.5
W	Baseline 8a Hilleshog 9093RR	15.16	98.1	12.62	98.4	252.42	98.4	40.06	93.8	10,220.6	93.3	90.07	100.4	77.18	100.8
X	Crystal M002	15.44	99.9	12.75	99.4	254.93	99.4	43.47	101.8	11,135.6	101.7	89.54	99.8	76.05	99.3
Y	Filler #4	15.30	99.0	12.64	98.6	252.90	98.6	42.73	100.0	10,885.2	99.4	89.50	99.7	82.29	107.5
Z	Filler #1	15.88	102.8	13.30	103.7	266.03	103.7	41.34	96.8	10,947.6	100.0	90.32	100.6	76.49	99.9
AA	Baseline 9a SV RR863	15.48	100.2	12.97	101.1	259.38	101.1	42.02	98.4	10,898.6	99.5	90.44	100.8	73.43	95.9
AB	Hilleshog 2219	15.70	101.6	13.19	102.8	263.77	102.8	38.48	90.1	10,230.2	93.4	90.54	100.9	76.87	100.4
AC	Filler #3	15.46	100.0	12.77	99.6	255.44	99.6	45.47	106.4	11,613.1	106.0	89.42	99.6	78.60	102.7
AD	Hilleshog 2398	15.57	100.8	12.87	100.4	257.42	100.4	41.76	97.8	10,702.7	97.7	89.27	99.5	75.67	98.8
AE	SV 817	15.10	97.7	12.57	98.0	251.41	98.0	44.06	103.2	11,051.2	100.9	90.10	100.4	74.11	96.8
AF	SV 881	15.71	101.6	13.00	101.4	259.92	101.4	42.52	99.5	10,944.1	99.9	89.42	99.6	75.42	98.5
AG	Baseline 10a Crystal M623	15.35	99.3	12.75	99.5	255.09	99.5	41.41	96.9	10,517.4	96.0	89.73	100.0	78.59	102.6
AH	Baseline 11a Beta 9780	15.62	101.1	13.07	101.9	261.36	101.9	42.81	100.2	11,203.5	102.3	90.20	100.5	78.14	102.0
AI	SV 894	15.60	100.9	13.01	101.5	260.28	101.5	42.63	99.8	11,145.1	101.8	90.09	100.4	78.43	102.4
AJ	Hilleshog 2379	15.31	99.1	12.85	100.2	256.97	100.2	42.61	99.8	10,932.0	99.8	90.39	100.7	80.43	105.0
AK	SV RR862	15.25	98.7	12.73	99.2	254.58	99.3	42.32	99.1	10,798.8	98.6	90.14	100.4	77.76	101.6
AL	Crystal M115	16.40	106.1	13.60	106.1	272.04	106.1	39.96	93.6	10,917.3	99.7	89.62	99.9	70.87	92.6
AM	SV 818	14.90	96.4	12.36	96.4	247.17	96.4	43.47	101.8	10,710.4	97.8	89.86	100.1	75.77	99.0
AN	Beta 9098	15.61	101.0	13.07	101.9	261.38	101.9	44.69	104.6	11,698.9	106.8	90.47	100.8	77.87	101.7
AO	Crystal M168	15.66	101.3	13.03	101.6	260.59	101.6	45.51	106.5	11,848.7	108.2	89.93	100.2	73.49	96.0
AP	Beta 9124	15.71	101.7	13.19	102.8	263.71	102.8	43.93	102.8	11,548.1	105.4	90.42	100.7	82.03	107.1
AQ	Crystal M089	15.31	99.1	12.75	99.4	254.98	99.4	44.38	103.9	11,336.6	103.5	90.11	100.4	78.15	102.1
AR	Beta 9986	15.02	97.2	12.42	96.9	248.45	96.9	46.02	107.7	11,359.5	103.7	89.57	99.8	80.06	104.6
AS	SV RR863	15.42	99.8	12.83	100.0	256.54	100.0	43.55	101.9	11,211.7	102.4	89.84	100.1	76.08	99.4
AT	Hilleshog 2395	15.05	97.4	12.31	96.0	246.17	96.0	42.83	100.3	10,566.1	96.5	89.05	99.2	77.00	100.6
AU	Crystal M028	15.98	103.4	13.18	102.8	263.50	102.7	40.97	95.9	10,757.8	98.2	89.11	99.3	77.39	101.1
AV	Beta 9810	15.85	102.5	13.22	103.1	264.43	103.1	41.31	96.7	10,932.3	99.8	89.90	100.2	76.71	100.2
AW	Beta 9155	15.24	98.6	12.75	99.4	254.94	99.4	44.53	104.3	11,299.3	103.2	90.30	100.6	78.66	102.7
Trial mean		15.45	100.0	12.82	100.0	256.46	100.0	42.72	100.0	10,951.9	100.0	89.75	100.0	76.57	100.0
Residual		0.12		0.15		58.67		3.20		327,469.3		0.90		29.10	
%CV		1.88		2.43		2.43		3.15		4.28		0.88		6.12	
LSD (0.05)		0.39		0.43		8.67		2.03		647.56		1.07		6.10	

Murdock OVT

		Sugar		PercentES		EST		TonsPerAcre		ESA		Purity		Emergence	
ID	Entry Name	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean	Mean	% Mean
A	Baseline 12a Hilleshog 2327	14.90	99.1	12.61	100.4	252.15	100.4	43.42	97.8	11,086.0	99.4	91.15	100.9	72.64	97.8
B	Hilleshog 2397	15.03	100.0	12.71	101.2	254.08	101.2	44.58	100.4	11,364.8	101.9	91.18	101.0	69.84	94.0
C	SV 883	14.75	98.1	12.20	97.2	244.02	97.2	44.47	100.1	10,856.6	97.4	89.73	99.4	80.14	107.9
D	Crystal M977	14.94	99.4	12.26	97.7	245.19	97.7	48.40	109.0	11,862.6	106.4	89.12	98.7	70.78	95.3
E	Crystal M106	15.56	103.5	12.85	102.3	256.92	102.3	48.15	108.4	12,298.1	110.3	89.44	99.0	77.43	104.2
F	Beta 9952	14.77	98.3	12.26	97.6	245.13	97.6	39.62	89.2	9,674.0	86.8	90.03	99.7	71.53	96.3
G	Crystal M143	15.11	100.5	12.62	100.5	252.38	100.5	47.47	106.9	11,900.6	106.7	90.48	100.2	71.73	96.5
H	Filler #2	15.22	101.2	13.03	103.8	260.66	103.8	45.27	101.9	11,800.3	105.8	91.99	101.9	74.85	100.7
I	Beta 9088	15.42	102.6	12.86	102.4	257.13	102.4	45.26	101.9	11,481.2	103.0	90.12	99.8	72.15	97.1
J	Beta 9780	15.30	101.8	12.82	102.1	256.36	102.1	45.62	102.7	11,676.5	104.7	90.43	100.1	73.32	98.7
K	Beta 9131	15.31	101.8	12.78	101.8	255.70	101.8	48.07	108.2	12,255.7	109.9	90.13	99.8	82.81	111.5
L	Hilleshog 2327	14.65	97.4	12.10	96.4	242.05	96.4	45.19	101.8	10,937.5	98.1	89.60	99.2	74.27	100.0
M	Hilleshog 2396	14.68	97.7	12.32	98.1	246.38	98.1	44.24	99.6	10,903.1	97.8	90.65	100.4	70.59	95.0
N	SV 805	14.76	98.2	12.28	97.8	245.50	97.8	41.74	94.0	10,273.7	92.1	90.15	99.8	69.09	93.0
O	Beta 9103	16.08	107.0	13.31	106.0	266.11	106.0	45.06	101.4	12,079.5	108.3	89.38	99.0	74.87	100.8
P	SV 893	14.66	97.5	12.29	97.9	245.66	97.8	42.14	94.9	10,301.6	92.4	90.51	100.2	70.45	94.8
Q	Hilleshog 2399	14.89	99.1	12.43	99.0	248.56	99.0	46.27	104.2	11,493.7	103.1	90.30	100.0	74.74	100.6
R	Beta 9044	15.99	106.4	13.56	108.0	271.24	108.0	43.24	97.4	11,740.7	105.3	91.15	100.9	77.97	104.9
S	Crystal M837	15.22	101.2	12.64	100.7	252.90	100.7	45.39	102.2	11,535.7	103.5	89.90	99.6	73.14	98.4
T	Crystal M951	14.47	96.2	11.90	94.8	238.02	94.8	46.91	105.6	11,199.5	100.4	89.48	99.1	74.72	100.6
U	SV 819	14.86	98.8	12.33	98.2	246.58	98.2	40.95	92.2	10,092.3	90.5	89.95	99.6	69.12	93.0
V	Baseline 7a Hilleshog 4017RR	15.16	100.9	12.73	101.4	254.68	101.4	41.52	93.5	10,626.8	95.3	90.59	100.3	75.86	102.1
W	Baseline 8a Hilleshog 9093RR	14.33	95.3	11.83	94.3	236.66	94.3	42.10	94.8	10,026.8	89.9	89.81	99.4	76.53	103.0
X	Crystal M002	15.24	101.4	12.70	101.2	254.05	101.2	46.99	105.8	11,888.0	106.6	90.19	99.9	70.62	95.0
Y	Filler #4	15.23	101.3	12.83	102.2	256.68	102.2	43.40	97.7	11,190.3	100.4	90.92	100.7	75.50	101.6
Z	Filler #1	15.65	104.1	13.20	105.1	263.99	105.1	43.97	99.0	11,545.1	103.5	90.98	100.7	73.11	98.4
AA	Baseline 9a SV RR863	14.83	98.6	12.33	98.2	246.65	98.2	43.25	97.4	10,650.6	95.5	90.01	99.7	76.26	102.6
AB	Hilleshog 2219	14.50	96.4	12.05	96.0	240.92	96.0	41.63	93.7	10,000.4	89.7	90.04	99.7	75.84	102.1
AC	Filler #3	14.97	99.6	12.39	98.7	247.80	98.7	44.59	100.4	11,038.2	99.0	89.75	99.4	76.82	103.4
AD	Hilleshog 2398	14.83	98.7	12.47	99.4	249.47	99.4	41.64	93.8	10,357.1	92.9	90.77	100.5	73.67	99.2
AE	SV 817	15.15	100.8	12.73	101.4	254.71	101.4	41.88	94.3	10,672.2	95.7	90.71	100.5	65.40	88.0
AF	SV 881	14.95	99.5	12.60	100.4	252.08	100.4	43.48	97.9	10,909.1	97.8	90.97	100.7	68.21	91.8
AG	Baseline 10a Crystal M623	14.58	97.0	12.12	96.6	242.45	96.6	44.41	100.0	10,799.7	96.9	90.06	99.7	77.37	104.1
AH	Baseline 11a Beta 9780	15.19	101.1	12.67	101.0	253.46	101.0	47.19	106.2	11,937.2	107.1	90.11	99.8	73.82	99.4
AI	SV 894	14.70	97.8	12.30	98.0	246.01	98.0	44.49	100.2	10,893.7	97.7	90.49	100.2	76.53	103.0
AJ	Hilleshog 2379	14.90	99.1	12.48	99.4	249.67	99.4	40.57	91.3	10,206.7	91.5	90.51	100.2	78.29	105.4
AK	SV RR862	14.48	96.3	11.97	95.3	239.29	95.3	40.33	90.8	9,632.0	86.4	89.71	99.3	77.81	104.7
AL	Crystal M115	15.88	105.7	13.24	105.4	264.75	105.4	44.70	100.6	11,814.4	106.0	90.03	99.7	75.86	102.1
AM	SV 818	14.81	98.5	12.40	98.8	248.00	98.8	43.27	97.4	10,706.2	96.0	90.68	100.4	75.25	101.3
AN	Beta 9098	14.97	99.6	12.50	99.5	249.88	99.5	43.88	98.8	11,026.2	98.9	90.22	99.9	70.95	95.5
AO	Crystal M168	15.34	102.1	12.85	102.4	256.97	102.3	44.67	100.6	11,513.9	103.3	90.43	100.1	70.43	94.8
AP	Beta 9124	15.66	104.2	13.18	105.0	263.66	105.0	47.40	106.7	12,477.1	111.9	90.79	100.5	81.96	110.3
AQ	Crystal M089	14.70	97.8	12.05	96.0	241.10	96.0	47.89	107.8	11,520.6	103.3	89.18	98.8	78.76	106.0
AR	Beta 9986	14.38	95.7	11.86	94.5	237.17	94.5	47.38	106.7	11,269.1	101.1	89.68	99.3	69.11	93.0
AS	SV RR863	15.08	100.3	12.78	101.8	255.54	101.8	42.37	95.4	10,870.1	97.5	91.26	101.1	72.18	97.1
AT	Hilleshog 2395	14.53	96.6	12.06	96.1	241.19	96.1	46.87	105.5	11,245.2	100.9	90.03	99.7	70.98	95.5
AU	Crystal M028	15.55	103.4	13.08	104.2	261.70	104.2	42.66	96.1	11,102.7	99.6	90.78	100.5	77.53	104.3
AV	Beta 9810	15.52	103.2	13.14	104.7	262.79	104.7	43.62	98.2	11,487.2	103.0	91.14	100.9	79.48	107.0
AW	Beta 9155	14.92	99.3	12.42	99.0	248.45	99.0	48.71	109.7	12,114.4	108.7	90.18	99.9	80.33	108.1
Average		15.03	100.0	12.55	100.0	251.07	100.0	44.41	100.0	11,149.7	100.0	90.30	100.0	74.30	100.0
Residual		0.18		0.22		89.22		2.20		305,679.1		1.66		42.56	
%CV		2.45		3.31		3.31		2.79		4.31		1.27		7.73	
LSD (0.05)		0.48		0.53		10.69		1.68		625.65		1.46		7.38	

Date of Harvest Trials

Cody Groen[1]
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Introduction
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.

Objective
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. 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.

Materials and Methods
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 2021, the three Date of Harvest Trials were conducted at a location near Murdock, Lake Lillian, and Hector. 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 and Discussion
The first harvest date for the trial was July 26, 2021. Harvesting continued on a weekly basis until October 12, 2021. Harvest was conducted once a week, although intervals of exactly seven days were unachievable due to weather. A total of twelve harvest timings were completed in 2021. Trials sites had even stands, uniform canopy development, minimal root rot, and minimal CLS.

Table 1 shows the average pounds extractable sugar per acre (ESA) increase per day for each of the past eleven years, between mid-August to early-October. From 2011-2020, the daily average rate of increase in ESA was 80.2 pounds extractable sugar per day. The increase in ESA per day for 2021 of 106.8 pounds was greater than the long-term mean rate of gain. This rate of gain for ESA is a new record, with weekly gains on ESA being 6.1 lbs ESA greater than the prior record. As discussed below, this is driven by abnormally high rates of gain for TPA in 2021. 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 approximately 0.41% per week. In 2021, sugar increased more slowly than the long-term average at 0.02% per day and approximately 0.17% per week. This rate is approximately half the rate of increase compared to the eleven-year average. Figure 2 illustrates the data from 2021 for sugar percent rate of gain. Despite rate of gains on sucrose being low, ESA rate of gains were above average, driven by high rate of gains on TPA in 2021.

Table 3 shows the average rate of gain of TPA for the eleven-year period of 2011-2021. The long-term average is 0.21 TPA gained per day, and approximately 1.45 tons per week. The 2021 rate of gain for TPA was the highest of the eleven seasons of data. This record is shown with a daily rate of gain of 0.37 TPA and approximately 2.61 TPA per week. This rate of gain is 0.60 TPA per week greater than the prior record. Figure 3 illustrates the data collected in 2021.

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 2021, prepile began for SMBSC producers on 8/25/2021 and ended 47 days later on 10/10/2021, with main harvest beginning 10/11/2021.

Data from the 2021 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 8/25/2021. These revenue values are left blank because the start date of prepile and the gain there-after influence the daily premium calculation. The 2021 prepile daily premium wasn't designed to compensate for the lower yield and quality of beets harvested prior to 8/25/2021. 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 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 10/12/2021 (the nearest to 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 2021 Date of Harvest Trial, revenue per acre averaged 15.7% 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".

Conclusion

Crop Year 2021 saw record rates of growth for yield and extractable sugar per acre for SMBSC producers as well as set a new record for the yield achieved per acre for the Cooperative. This is reflected in the 2021 Date of Harvest Data. Further, the data generated in this trial would support the claim that the prepile premium program worked as designed, paying premiums so that deliveries in the prepile period are at, or above, the payments for deliveries on the first day of main harvest.

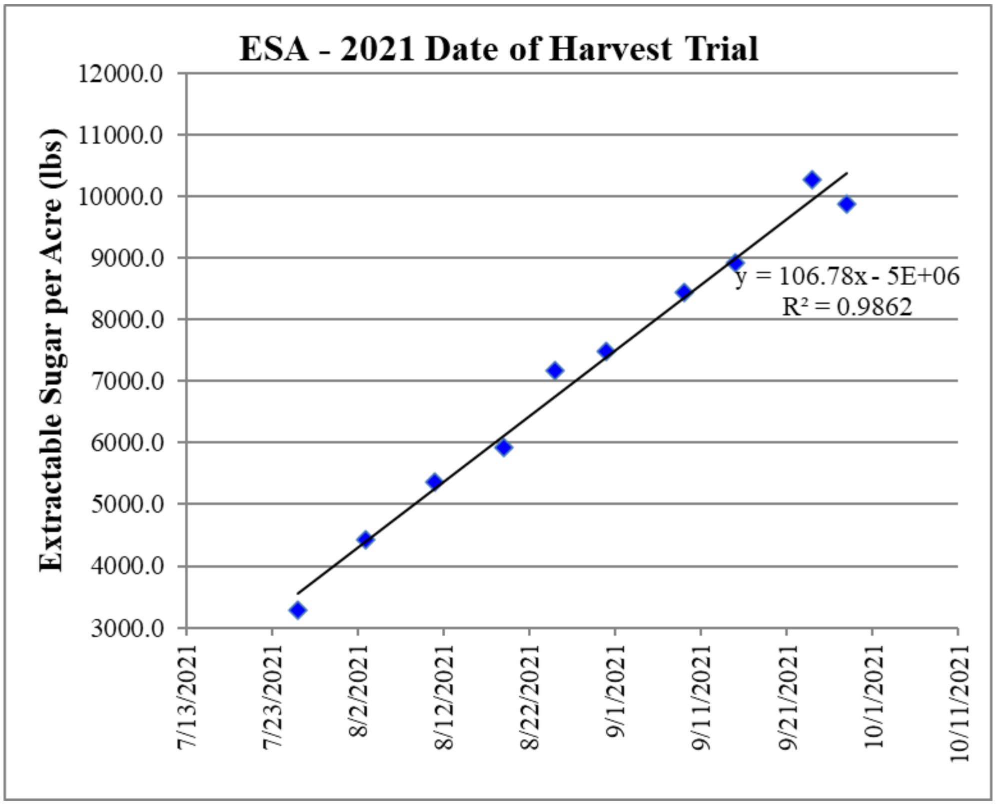

Figure 1. Extractable sugar per acre (ESA) data collected during the 2021 Date of Harvest trials, plotted across the harvest period, depicting a positive trend.

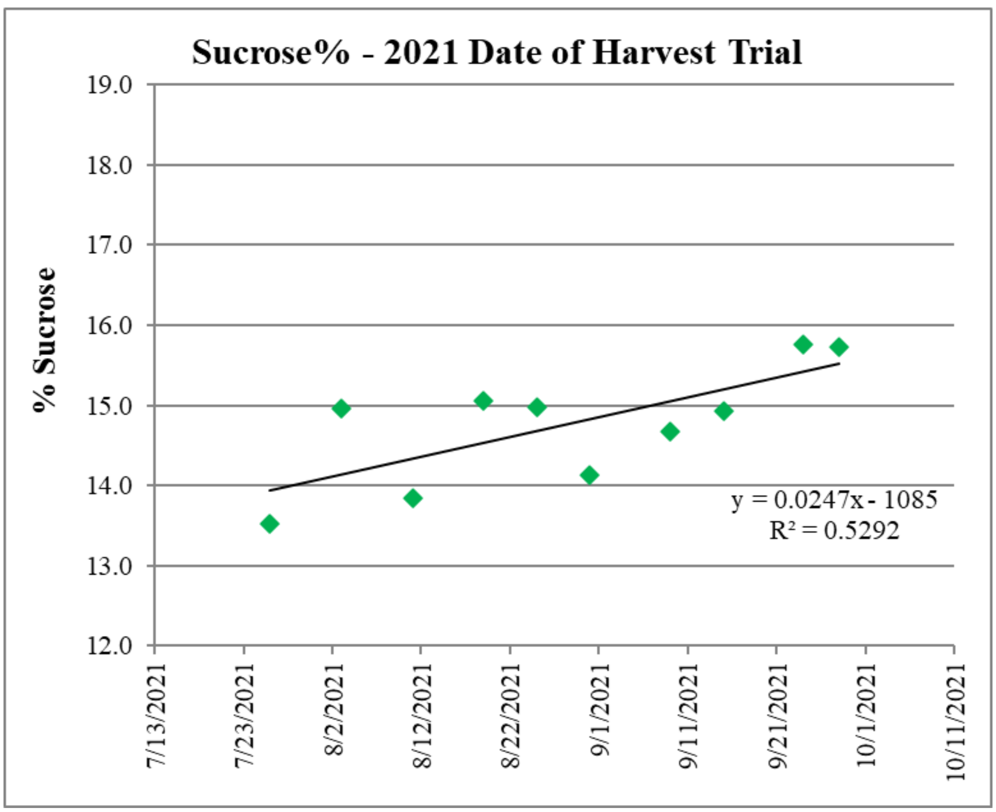

Figure 2. Sugar percent data collected during the 2021 Date of Harvest Trials, plotted across the harvest period, depicting a general positive trend.

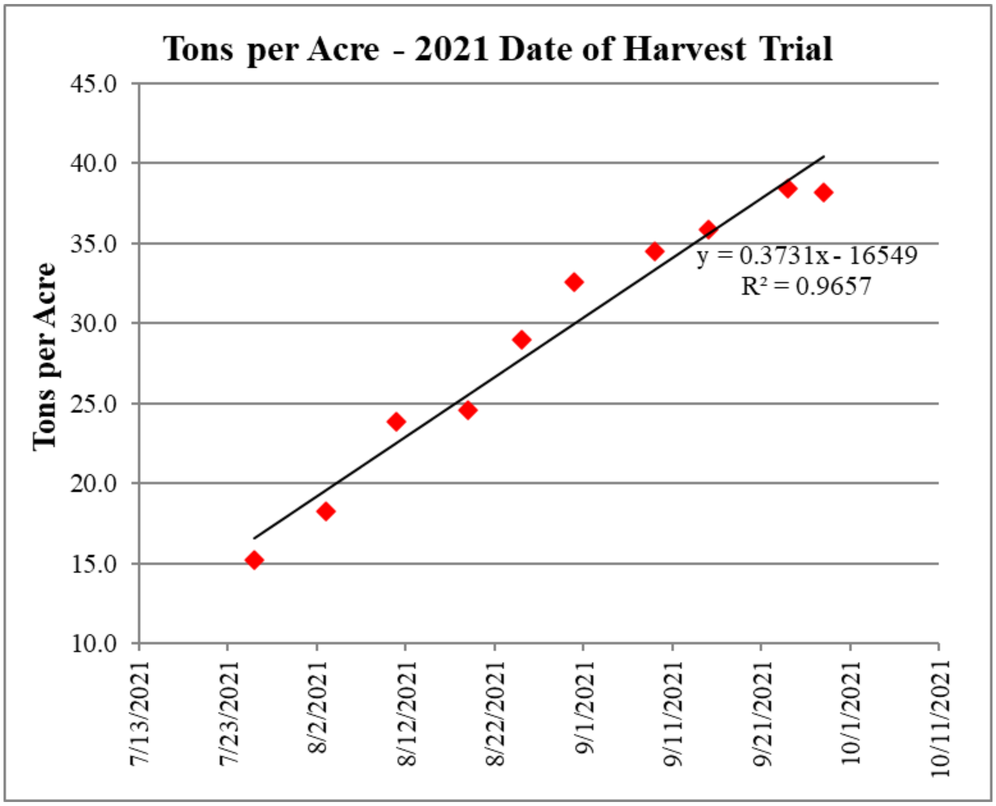

Figure 3. Tons per acre data collected during the 2021 Date of Harvest Trials, plotted across the harvest period, depicting a general positive trend.

Table 1.

2011-2021 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
Average (2011-2020)	80.2
2021	106.8

Table 2.

2011-2021 Regression Analysis of Percent Sugar Increase per Day

Year	Percent Sugar Increase per Day (%)	Percent Sugar Increase per Week (%)
2011	0.10	0.68
2012	0.09	0.61
2013	0.05	0.38
2014	0.09	0.60
2015	0.06	0.44
2016	0.03	0.18
2017	0.06	0.40
2018	0.005	0.04
2019	0.04	0.30
2020	0.07	0.47
Average (2011-2020)	0.06	0.41
2021	0.02	0.17

Table 3.

2011-2021 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
Average (2011-2020)	0.21	1.45
2021	0.37	2.61

Table 4.

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
7/26/2021	13.5	87.9	15.2	10.8	216.1	3284.0			**N/A**	7/26/2021
8/3/2021	15.0	88.6	18.2	12.2	243.4	4435.0			**N/A**	8/3/2021
8/11/2021	13.8	88.8	23.9	11.2	224.8	5366.6			**N/A**	8/11/2021
8/19/2021	15.1	87.5	24.6	12.0	240.6	5917.3			**N/A**	8/19/2021
8/25/2021	15.0	89.7	28.9	12.4	247.9	7173.3	56.3	123.3	**1**	8/25/2021
8/31/2021	14.1	88.9	32.5	11.5	230.0	7484.1	53.9	119.7	**2**	8/31/2021
9/9/2021	14.7	90.5	34.5	12.3	245.2	8455.3	65.6	120.0	**3**	9/9/2021
9/15/2021	14.9	90.4	35.8	12.5	249.2	8931.0	70.4	116.4	**4**	9/15/2021
9/24/2021	15.8	91.2	38.4	13.4	267.6	10278.3	86.8	119.0	**5**	9/24/2021
9/28/2021	15.7	89.2	38.1	13.0	259.0	9879.1	81.0	105.4	**6**	9/28/2021
10/8/2021	16.6	89.9	41.5	13.9	277.0	11485.5	100.0	106.1	**7**	10/8/2021
10/12/2021	15.8	91.1	44.1	13.4	268.2	11818.8	100.0	100.0	**Main Harvest**	10/12/2021

Cercospora Leaf Spot Early Detection Project

Mark Bloomquist[1], Lynsey Nass[1], Melvin Bolton[2], and Jonathan Neubauer[2]
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[2]USDA Agricultural Research Service, Fargo, ND

Introduction: Cercospora leaf spot is the most destructive foliar disease of sugar beets in the SMBSC growing area. Cercospora leaf spot is caused by the fungus *Cercospora beticola*. It is not known exactly how early in the season that Cercospora enters the sugar beet plant. Detecting the presence of Cercospora in the sugar beet plant prior to the leaf spot symptoms developing could help time the first fungicide application and thus increase the effectiveness of the fungicide program. This project was done in cooperation with Dr. Melvin Bolton and Jonathan Neubauer of the USDA/ARS in Fargo, ND.

Objective: The objective of this project was to sample leaves from sugar beets along common lines to previous year's sugar beet fields and attempt to detect the DNA of *C. beticola* in these leaf samples. The detection of Cercospora DNA is possible through the use of quantitative polymerase chain reaction (qPCR) analysis. The qPCR machine technology allows us to amplify and detect small amounts of Cercospora DNA in the sugar beet leaf samples if Cercospora is present. Detecting Cercospora DNA early in the growing season could potentially help to time early fungicide applications.

Materials and Methods: Beginning the week of June 7, SMBSC Agriculturists collected leaf samples from three sugar beet fields in their district that were planted on a common line to a 2020 sugar beet field. These same fields were sampled on a weekly basis until July 30. In addition to these fields, three research sites were also sampled each week. The results shown in this report only represent the results from the production fields and do not include results from research trial locations. The weekly leaf samples were taken from the same area of each field every week. Between 20-30 fields were sampled each week during this eight week period. Each field sample consisted of five to six sugar beet leaves. The leaf samples were delivered each week to SMBSC research personnel for analysis. Samples were taken on Tuesday and Wednesday of each week and stored in a refrigerator until Thursday or Friday when the analysis was performed.

Analysis of the field leaf samples was dependent on the supplies available each week. For the first few weeks of the study, we obtained ten leaf punches from the leaves supplied per field and used this as one sample. This sample was then duplicated in the Mic qPCR machine for a total of two replicates per field. For the remainder of the study, the leaves from each field were separated into two groups and one sample was obtained per group of leaves. This provided two samples for analysis per field. Each of these samples was duplicated in the Mic qPCR machine, so we had a total of two samples with two additional replicates per field. For all positive testing samples, we also re-ran each of these samples to confirm the detection of Cercospora DNA. For a field to be reported as positive for that week, two or more positive results had to be found for that field.

Leaf samples from each field were prepared for qPCR analysis according to the protocol provided by Dr. Melvin Bolton and Jon Neubauer of the USDA/ARS in Fargo, ND. Leaf samples were prepared using DNeasy® Plant Pro Kit (Qiagen, Germantown, MD). PCR analysis was conducted with a Mic qPCR cycler (Bio Molecular Systems, Upper Coumera Australia). Numerical values and graphical representations of the data results were obtained.

Figure 1 is an example of the graphical representation of the analysis report that was produced by the Mic qPCR software. The multi-color lines near the bottom of the picture represent samples from that date testing negative. The upper curved line represents the Cercospora control sample, showing that the qPCR analysis successfully detected Cercospora DNA in the analysis. The curved line midway up the graph represents a field sample with strong results for the detection of Cercospora DNA.

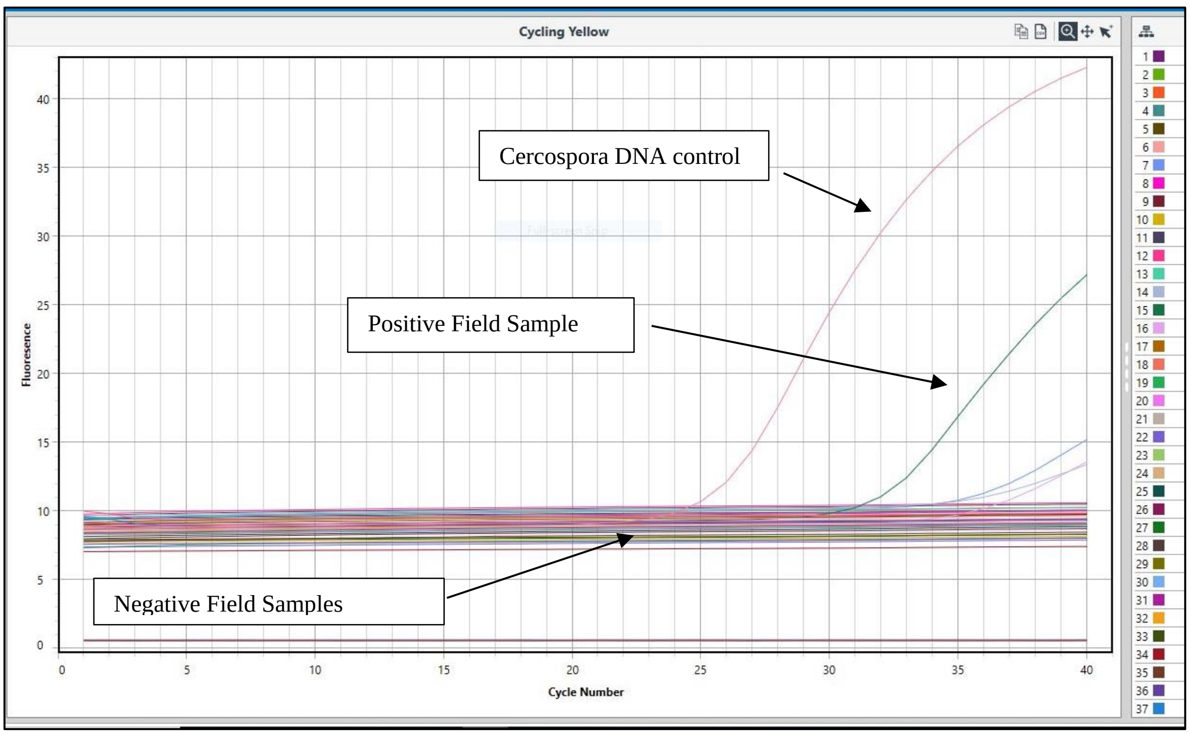

Figure 1. Example of graphical representation of Mic qPCR analysis of leaf samples.

Results and Discussion: Analysis of samples began on June 10-11 for the samples taken earlier that week. In addition to the field samples, a distilled water control and Cercospora control sample were added to each qPCR analysis as check samples. These check samples provided confidence that the qPCR procedure operated correctly by providing values to compare against the field sample values generated by the analysis. In the June 10-11 sample analysis, the control sample results indicated an issue with the analysis. The issue was traced back to a bad PCR primer which was corrected for future week's analyses. Due to the issues with the June 10-11 samples, the data reporting for the 2021 project begins with the week of June 17-18.

A summary of Cercospora detections by week can be found in Table 1. Cercospora DNA was detected in three fields during the June 17-18 period. A text message was sent to shareholders to communicate the detection of Cercospora in the samples that week and to encourage shareholders to consider starting fungicide spray programs in the upcoming week. Over the next four weeks, Cercospora detections remained fairly low across the fields sampled. 2021 field observations of CLS development agreed with the lower detection of Cercospora DNA seen during this timeframe. In 2020 by contrast, Cercospora detections during this same time period were considerably higher. By late July, DNA detections of Cercospora had increased as well as visual observations of CLS presence in sugar beet fields. Although CLS could be visually observed in some fields by late July-early August, the levels of disease present remained low. The Cercospora DNA detection project ended for the 2021 season in the final week of July.

Date	Cercospora Detections by Field	Percent of Fields with Positive Detection	Percent of Fields with Positive Detection To Date
June 17-18, 2021	3 of 25 fields	12.0%	12.0%
June 24-25, 2021	1 of 30 fields	3.3%	10.0%
July 1-2, 2021	1 of 27 fields	3.7%	14.8%
July 8-9, 2021	No detections	0.0%	14.8%
July 15-16, 2021	3 of 26 fields	11.5%	23.0%
July 22-23, 2021	11 of 26 fields	42.3%	53.8%
July 29-30, 2021	13 of 26 fields	50.0%	76.9%

Table 1. 2021 Cercospora detections by qPCR analysis.

Conclusions: The first year of this project in 2020 increased our knowledge of the equipment operation, sampling protocols, sample preparation, and interpretation of the data. The experience gained in 2020 was extremely helpful in the second year of this project. Cercospora can be detected in field samples using this technology prior to the development of foliar leaf spot symptoms. In both seasons, Cercospora DNA was discovered in asymptomatic sugar beet leaves in mid-June. This information can provide an early alarm of the infection of the sugar beet crop by this fungal disease. The detection of Cercospora presence in the crop can serve as a warning to SMBSC shareholders to begin their CLS fungicide programs for the season. The date of first detection may be different from season to season based on the environmental conditions of the year.

Acknowledgments: This project would not have been possible without the collaboration of Dr. Melvin Bolton and Jonathan Neubauer of the USDA/ARS in Fargo, ND. SMBSC is appreciative of their expertise and contributions to make the 2021 project successful.

Cercospora Leaf Spot Inoculum Reduction Trial

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Introduction: Cercospora Leaf Spot (CLS) is the most destructive foliar disease to impact sugar beet production in the SMBSC growing area. The increased presence of CLS in fields in recent years has led to a buildup of inoculum from one year to the next. The inoculum overwinters and generally persists in the soil for up to two years. Practicing a crop rotation of 3 to 4 years allows enough time for the inoculum to break down in the soil, but sugar beet fields planted along a common line to last years' sugar beet field could be exposed to high levels of inoculum early in the season.

Objective: A reduction in the amount of inoculum along common lines could slow disease development during the next growing season and decrease selection pressure on other methods of controlling the disease. Methods to reduce the amount of inoculum and slow the onset of disease development need to be explored.

Materials and Methods: A trial was conducted as a randomized complete block with four replications on a trial site near Renville that was planted to sugar beets in 2020. The beets were defoliated in the fall of 2020, but no tillage or harvest took place in the field. Since the site was previously sugar beets with a high infection of CLS, it was assumed there were ample levels of inoculum on the soil surface. Four methods for reducing CLS inoculum were tested in this trial using small plots 6 rows wide and 35 feet long (Table 1). Treatment 1 was the untreated check. Treatment 2 used Oxidate 2.0 (peroxyacetic acid) applied to the soil surface through a bike sprayer at 20gpa. The plots in Treatment 3 were tilled with a rotary tiller in the spring prior to planting to a depth of 4 inches to bury the residue. These tilled plots were raked by hand to create a firm seed bed for planting. Treatment 4 used Badge SC (copper product) at a low pH applied through a bike sprayer at 20gpa to the soil surface. Treatment 5 used propane to burn the residue and potentially destroy the overwintering spores. After treatments were applied to the trial area, Crystal M977 was planted at a high population (109,000 seeds/acre) without any additional seedbed preparation on May 12th. The trial was maintained weed free using normal best management practices. No fungicides were applied during the season to control CLS. Plots were rated for foliar damage using the KWS (Kleinwanzlebener Saatzucht) (1-9) scale with one being disease free and nine being completely necrotic. Foliar ratings began on July 12 and continued three times per week until the CLS infection overwhelmed the trial and the differences between treatments. Ratings were conducted by multiple raters and the average of those ratings are reported for each date (Table 2).

Table 1: Treatments used to reduce the carry-over of CLS inoculum.

Trt #	Treatment Description
1	Untreated
2	Oxidate 2.0 (2.5% conc.)
3	Tilled (4” deep)
4	Badge SC (4pts.) + N-tense
5	Heat (propane burner)

Results: The application of heat/burning of residue and the use of tillage to bury the inoculum significantly delayed the onset of CLS disease development in the 2021 trial (Table 2 and Figure 1). The Oxidate 2.0 and Badge SC treatments did not appear to impact the onset of disease in the 2021 trial and were not significantly different than the untreated check. These results are similar to the results from the 2019 and 2020 Inoculum Reduction Trials (Figures 2 and 3). The differences between the treatments were more pronounced in the 2021 season as the trial was conducted using a larger plot size. This larger plot size also maintained the treatment differences longer into the season. In smaller plots in 2019 and 2020 the treatment effects only lasted for a short period of time before adjacent treatments impacted the level of disease. After three years of testing with similar results we can conclude that the application of heat/burning of residue and burying the residue are both methods to reduce or delay the onset of disease. It may not be practical or economical to conduct these treatments across all acres, but it may be beneficial in areas where beets will be planted adjacent to the previous year's beets that had difficulty controlling the disease.

	Date of Rating								
Treatment	**12-Jul**	**14-Jul**	**16-Jul**	**19-Jul**	**21-Jul**	**23-Jul**	**26-Jul**	**30-Jul**	**2-Aug**
Untreated	4.6 a	5.4 a	5.9 a	6.9 a	7.4 a	7.5 a	8.1 a	8.8 a	9.0 a
Oxidate 2.0	4.2 a	5.2 a	5.8 a	6.5 a	7.0 a	7.3 a	8.0 a	8.8 a	9.0 a
Tilled	2.3 b	2.9 b	3.7 b	4.5 b	5.1 c	4.7 c	5.4 c	6.2 b	7.3 b
Badge SC	4.4 a	5.4 a	5.8 a	6.6 a	7.1 a	7.5 a	8.0 a	8.7 a	9.0 a
Heat	2.6 b	3.3 b	3.9 b	4.9 b	5.6 b	5.3 b	5.8 b	6.5 b	7.6 b
Mean	3.6	4.4	5.0	5.9	6.4	6.4	7.1	7.8	8.4
CV	8.367	6.5	5.7	5.7	4.7	3.9	2.3	2.6	3.2
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.47	0.44	0.44	0.51	0.47	0.39	0.25	0.31	0.41

Table 2: Foliar ratings using KWS (1-9) scale. Ratings are an average of all raters for each date.

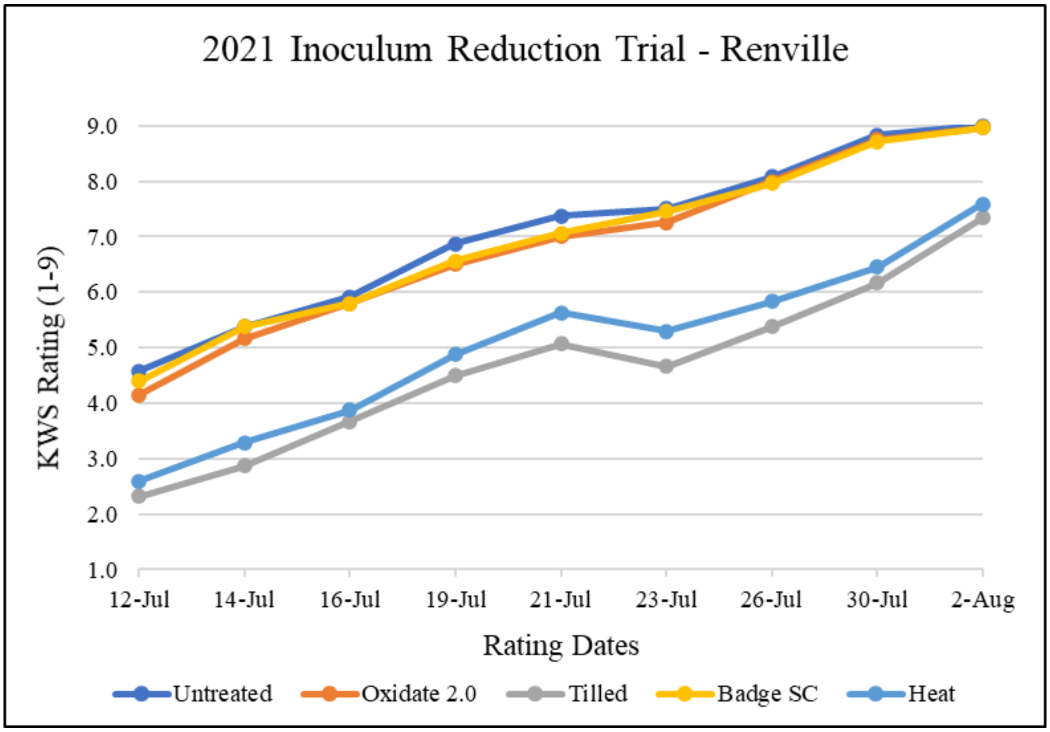

Figure 1: 2021 foliar ratings using KWS (1-9) scale. Ratings are an average of all raters for each date.

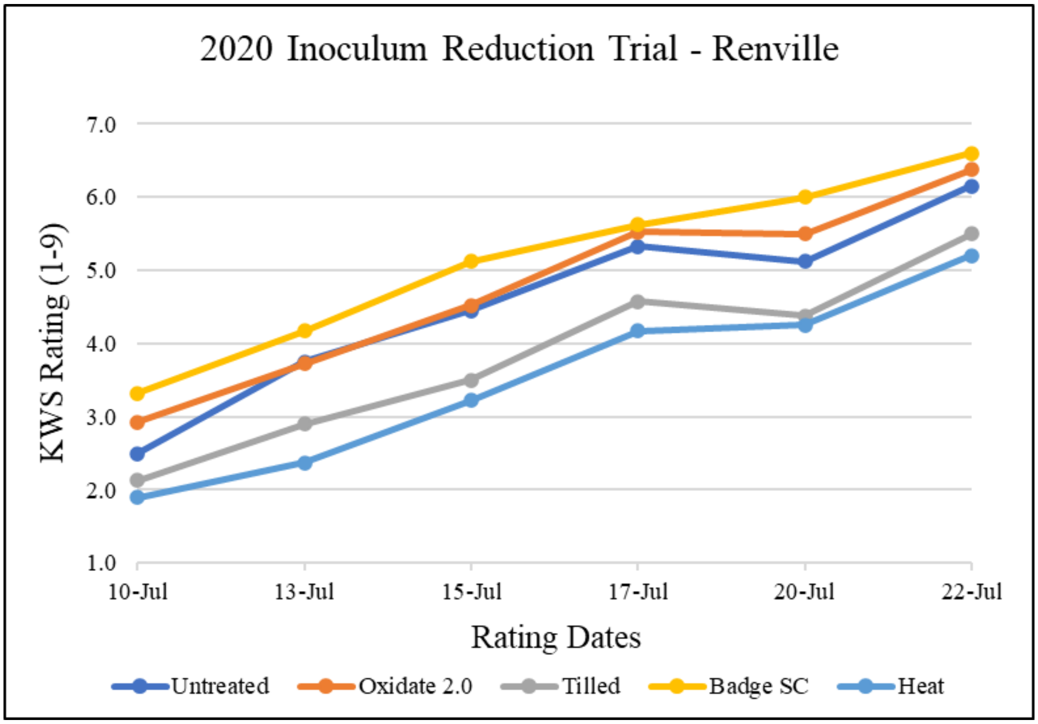

Figure 2: 2020 foliar ratings using KWS (1-9) scale. Ratings are an average of all raters for each date.

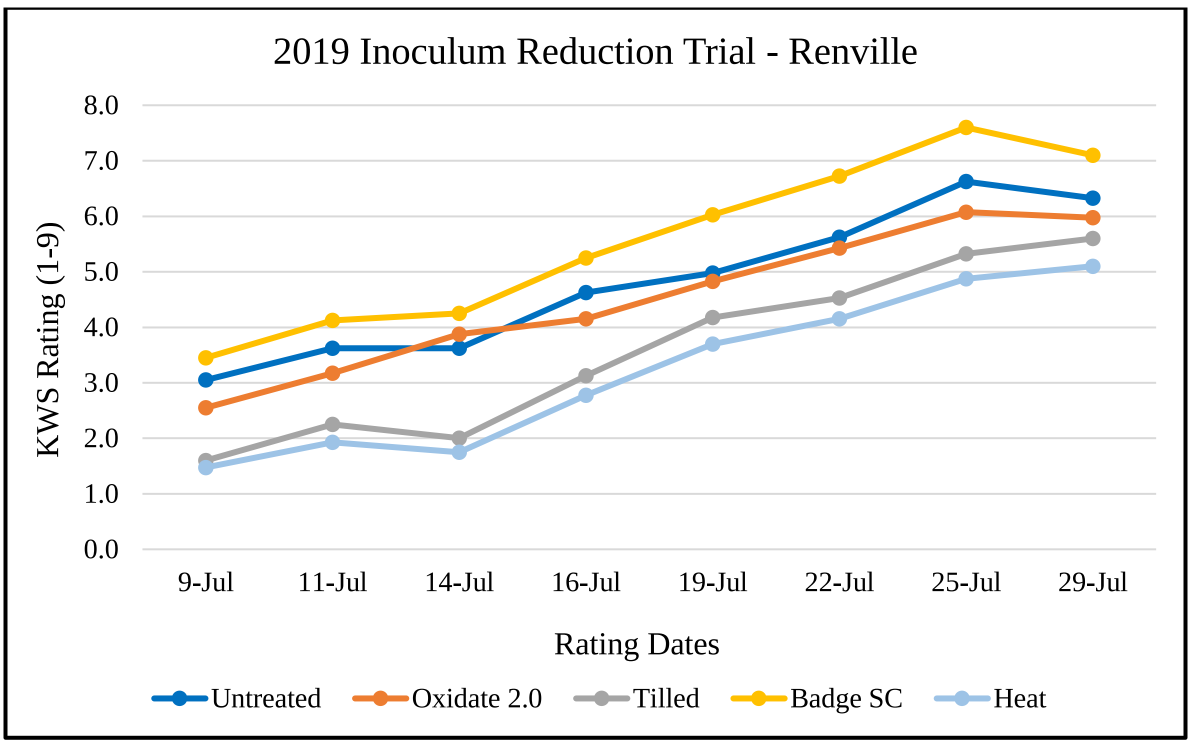

Figure 3: 2019 foliar ratings using KWS (1-9) scale. Ratings are an average of all raters for each date.

Cercospora Leaf Spot Fungicide Screening Trials

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Introduction: 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. Without a new "silver bullet", the key to controlling CLS will be utilizing best management practices that include an appropriately timed fungicide program that utilizes multiple modes of action.

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. Due to the high levels of disease pressure, an effective fungicide program is necessary to grow a profitable crop. Trials need to be conducted to test the efficacy of individual fungicides and season long fungicide programs.

Materials and Methods: Two trials were conducted as randomized complete block with four replications. The Program Trial was located near Clara City and the Fungicide Screening Trial was located near Hector, MN. These trials evaluated fungicides in a program setting, but also for individual efficacy. The Clara City site was planted on April 24th using Crystal M977. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 2.47 lbs./acre of 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 June 28th. Six fungicide applications were made in the Program Trial beginning June 30th and continuing on a ten to twelve-day spray interval. The Hector site was planted on April 29th using Crystal M977. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 3.1 lbs./acre of 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 8th. Five fungicide applications were made in the Fungicide Screening Trial beginning July 12th and continuing on a ten to twelve-day spray interval.

Applications were made using a custom-made tractor mounted sprayer traveling 3.3mph with a spray volume of 20gpa and 60psi, utilizing XR11002 spray nozzles. Each plot consisted of six rows that were 40ft 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 10th at the Hector site and on September 23rd at the Clara City site using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the lifter 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.

Program Trial Results: Few significant differences were found in the yield and quality parameters of the Program Trial (Table 1). The untreated check had significantly lower yield and quality parameters compared to all other treatments. The program with Badge SC as the tank-mix partner in all applications had significantly lower tons per acre and ESA than most of the other treatments. The remainder of the programs were very similar with regard to yield.

More differences were observed in the visual foliar ratings (Table 2). The untreated check had a significantly higher rating throughout the season than all other treatments. The programs that contained copper tank-mix partners had higher foliar ratings than programs that only used EBDC products for tank-mix partners. All programs that utilized EBDC in every application had similar foliar ratings.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	13.2 b	31.6 d	10.9 b	217.5 b	6861.1 c	89.9
Standard Program	15.3 a	43.1 ab	12.8 a	255.9 a	11015.6 ab	90.3
Standard Program w/ 2 Badge	15.7 a	42.8 bc	13.3 a	265.9 a	11375.6 a	91.1
Standard Program w/ 2 Ultim	15.5 a	43.8 ab	13.1 a	262.2 a	11486.2 a	91.2
Standard Program w/ All Badge	15.3 a	40.1 c	12.9 a	257.4 a	10346.5 b	91.1
Standard Program w/ All Ultim	15.4 a	43.0 ab	13.1 a	262.8 a	11290.6 a	91.7
Standard Program w/ Regev	15.6 a	43.7 ab	13.0 a	260.7 a	11387.0 a	90.3
Standard Program w/ 2 Proline	15.4 a	44.2 ab	12.9 a	257.1 a	11357.7 a	90.3
Standard Program w/ Provysol	15.4 a	45.2 ab	13.1 a	261.9 a	11672.1 a	91.2
Standard Program w/ Veltyma	15.5 a	45.7 a	12.9 a	257.9 a	11768.0 a	89.9
Mean	15.2	42.3	12.8	255.9	10856.0	90.7
CV%	2.4	4.5	4.0	4.0	5.9	1.8
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.798
lsd (0.05)	0.53	2.78	0.74	14.8	933.9	ns

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

Treatment	30-Jul	6-Aug	16-Aug	25-Aug	8-Sep	15-Sep
Check	3.9 a	5.2 a	8.3 a	9.0 a	9.0 a	9.0 a
Standard Program	1.2 c	1.4 d	1.7 g	2.7 e	3.4 ef	3.9 e
Standard Program w/ 2 Badge	1.3 c	1.6 cd	2.4 de	3.7 cd	4.7 d	5.4 cd
Standard Program w/ 2 Ultim	1.4 c	1.7 c	2.5 d	3.7 d	4.8 d	5.4 d
Standard Program w/ All Badge	2.0 b	2.3 b	3.8 b	4.9 b	6.4 b	7.2 b
Standard Program w/ All Ultim	1.7 b	2.0 b	3.0 c	4.0 c	5.3 c	5.9 c
Standard Program w/ Regev	1.4 c	1.6 cd	2.1 ef	2.7 e	3.7 e	3.9 e
Standard Program w/ 2 Proline	1.3 c	1.6 cd	1.9 fg	2.7 e	3.4 ef	4.0 e
Standard Program w/ Provysol	1.4 c	1.7 c	1.9 fg	2.6 e	3.5 ef	4.2 e
Standard Program w/ Veltyma	1.4 c	1.7 c	1.8 g	2.6 e	3.2 f	3.8 e
Mean	1.7	2.1	2.9	3.9	4.7	5.3
CV%	10.7	9.4	6.4	6.6	5.5	6.5
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.26	0.28	0.27	0.37	0.38	0.50

Table 2: Foliar ratings for the Program Trial using the KWS 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.

Fungicide Screening Trial Results: Several significant differences were found in the yield and quality parameters of the Fungicide Screening Trial (Table 3). The untreated check had substantially lower yield and quality parameters than any of the other treatments. The treatments with only one mode-of-action and the Inspire XT with Oxidate 5.0 treatment had numerically lower extractable sugar per acre (ESA) than almost all other treatments with two modes-of-action.

The foliar ratings had similar results with the check having significantly higher ratings throughout the season and the treatments with only one mode-of-action also having higher foliar ratings than most treatments that contained two modes of action. Treatments that contained the tank-mix of Proline and Manzate Prostick had significantly lower ratings than all other treatments.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	13.0	27.1 f	10.1	202.8	5516.5 e	86.6
Manzate Prostick	13.8	31.1 abcde	10.8	215.1	6666.1 cd	86.3
Proline	14.1	29.6 def	11.3	224.8	6622.5 d	87.8
Proline + Manzate Prostick	14.2	32.0 abcde	11.3	225.7	7228.5 abcd	87.6
Lucento + Manzate Prostick	14.2	32.1 abcde	11.3	225.7	7248.5 abcd	87.2
Topguard + Manzate Prostick	13.9	32.8 abcde	11.2	224.0	7336.4 abcd	88.2
Regev + Manzate Prostick	13.8	34.4 ab	11.0	220.4	7546.9 abc	87.6
Timorex Act + Manzate Prostick	13.8	30.9 bcde	10.9	218.4	6759.7 bcd	87.4
Neem Oil + Manzate Prostick	13.7	31.5 abcde	10.9	217.4	6831.7 bcd	87.6
Eminent VP + Manzate Prostick	14.0	33.8 abc	11.1	221.3	7436.7 abcd	87.1
Inspire XT	14.0	29.4 ef	11.3	225.0	6614.2 d	87.9
Inspire XT + Manzate Prostick	13.9	31.9 abcde	10.9	217.7	6931.2 bcd	86.6
Proline(3.46oz) + Inspire2.0 + Manzate Prostick	14.1	32.2 abcde	11.2	223.7	7213.2 abcd	87.2
Proline(5.7oz) + Inspire2.0 + Manzate Prostick	14.1	33.7 abc	11.3	226.2	7634.8 ab	88.1
Inspire XT + Manzate Prostick + Microthiol	14.3	34.7 a	11.6	231.0	8000.5 a	88.4
Inspire XT + Badge SC	14.3	30.5 cdef	11.5	229.0	6974.7 bcd	87.8
Agri Tin + Manzate Prostick	14.0	32.7 abcde	11.1	221.7	7245.8 abcd	87.0
Provysol + Manzate Prostick	14.1	33.3 abc	11.2	223.0	7427.8 abcd	87.2
Inspire XT + Manzate + Vacciplant	14.4	31.4 abcde	11.6	231.8	7263.3 abcd	88.1
Inspire XT + Oxidate 5.0	13.7	30.6 cdef	10.7	213.7	6575.8 d	86.5
Delaro + Proline(1.7oz) + Manzate Prostick	14.0	33.2 abcd	11.3	225.6	7480.7 abcd	88.2
Delaro Complete + Proline(1.7oz) + Manzate P.	14.0	32.2 acbde	11.2	224.4	7234.2 abcd	88.1
Mean	14.0	31.9	11.1	222.2	7081.3	87.5
CV%	3.5	8.2	5.0	4.9	9.2	1.2
Pr>F	0.1398	0.031	0.168	0.1818	0.0031	0.235
lsd (0.05)	ns	3.7	ns	ns	920.8	ns

Table 3: Yield parameter results for the Fungicide Screening Trial. Values with different letters are significantly different.

Treatment	6-Aug	16-Aug	30-Aug	8-Sep
Check	4.1 a	6.4 a	9.0 a	9.0 a
Manzate Prostick	2.3 de	2.6 fgh	5.0 d	5.8 de
Proline	2.1 efg	2.4 gh	4.7 d	5.9 de
Proline + Manzate Prostick	1.5 i	1.7 i	2.3 h	3.3 i
Lucento + Manzate Prostick	2.0 fg	2.4 gh	3.7 fg	4.7 h
Topguard + Manzate Prostick	2.0 fg	2.6 fgh	3.5 g	4.7 h
Regev + Manzate Prostick	2.4 de	2.6 fgh	4.2 e	5.3 fg
Timorex Act + Manzate Prostick	2.5 cd	3.0 de	4.9 d	5.5 ef
Neem Oil + Manzate Prostick	2.9 b	3.3 cd	5.7 c	6.4 c
Eminent VP + Manzate Prostick	2.2 efg	2.6 fgh	3.8 efg	4.8 gh
Inspire XT	3.0 b	3.6 bc	6.7 b	7.6 b
Inspire XT + Manzate Prostick	2.1 efg	2.6 fgh	4.1 ef	5.1 fgh
Proline(3.46oz) + Inspire2.0 + Manzate Prostick	1.6 hi	1.8 i	2.1 hi	2.8 ij
Proline(5.7oz) + Inspire2.0 + Manzate Prostick	1.6 i	1.8 i	1.9 hi	2.5 j
Inspire XT + Manzate Prostick + Microthiol	1.9 g	2.3 h	3.9 efg	4.8 h
Inspire XT + Badge SC	2.8 bc	3.2 d	5.5 c	6.3 cd
Agri Tin + Manzate Prostick	2.3 def	2.6 fgh	3.9 efg	4.6 h
Provysol + Manzate Prostick	2.2 defg	2.7 efg	4.0 ef	4.8 gh
Inspire XT + Manzate + Vacciplant	1.9 gh	2.8 ef	3.8 efg	4.9 gh
Inspire XT + Oxidate 5.0	2.9 b	3.8 b	6.7 b	7.8 b
Delaro + Proline(1.7oz) + Manzate Prostick	1.3 i	1.7 i	1.8 i	2.6 j
Delaro Complete + Proline(1.7oz) + Manzate P.	1.5 i	1.9 i	2.1 hi	2.7 j
Mean	2.2	2.7	4.2	5.1
CV%	10.8	9.6	7.7	7.2
Pr>F	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.34	0.37	0.46	0.52

Table 4: Foliar ratings for the Fungicide Screening Trial using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different.

Conclusion: The results of the Fungicide Screening trial indicate that a CLS fungicide program that uses multiple modes of action in a single application will have superior performance over a program that applies only a single mode of action. The results of the Program Trial indicate that EBDC is a superior tank-mix partner over copper products, but the Fungicide Screening Trial shows that copper products can still be beneficial as a tank-mix partner, just not as good as EBDC. Proline continues to be the superior triazole product with all other triazoles and tin products being similar. No new products performed better than those currently utilized for CLS control. The performance of Proline and Manzate Prostick are similar to the results from previous studies.

Treatment		Rate/Acre	Application Code
Check	n/a	n/a	n/a
Standard Program	Proline	5.7 oz	A
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ 2 Badge	Proline	5.7 oz	A
	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABDE
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ 2 Ultim	Proline	5.7 oz	A
	Ultim	2.5 lbs	CF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABDE
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ all Badge	Proline	5.7 oz	A
	Badge SC	32 oz	ABCDEF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ all Ultim	Proline	5.7 oz	A
	Ultim	2.5 lbs	ABCDEF
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ REGEV	Proline	5.7 oz	A
	SuperTin	8 oz	BDF
	REGEV	8.5 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Eminent VP	13 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ 2 Proline	Proline	5.7 oz	AE
	SuperTin	8 oz	BDF
	Inspire XT	7 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ Provysol and Lucento	Proline	5.7 oz	A
	SuperTin	8 oz	BDF
	Lucento	5.5 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Provysol	4 oz	E
	Masterlock	6.4 oz	ABCDEF
Standard Program w/ Veltyma and Lucento	Proline	5.7 oz	A
	SuperTin	8 oz	BDF
	Lucento	5.5 oz	C
	Manzate Prostick	2 lbs	ABCDEF
	Veltyma	8 oz	E
	Masterlock	6.4 oz	ABCDEF

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

Table 6: Fungicide Screening Trial treatment list.

Treatment	Application Rate per Acre
Check	n/a
Manzate Prostick	2 lbs
Proline	5.7 oz
Proline Manzate Prostick	5.7 oz 2 lbs
Lucento Manzate Prostick	5.5 oz 2 lbs
Topguard Manzate Prostick	14 oz 2 lbs
REGEV Manzate Prostick	8.5 oz 2 lbs
Timorex Act Manzate Prostick	29.8 oz 2 lbs
Neem Oil Manzate Prostick	40 oz 2 lbs
Eminent VP Manzate Prostick	13 oz 2 lbs
Inspire XT	7 oz
Inspire XT Manzate Prostick	7 oz 2 lbs
Proline Inspire 2.0 Manzate Prostick	3.56 oz 6.84 oz 2 lbs
Proline Inspire 2.0 Manzate Prostick	5.7 oz 6.84 oz 2 lbs
Inspire XT Manzate Prostick Microthiol Disperss	7 oz 2 lbs 5 lbs
Inspire XT Badge SC	7 oz 2 pints
Agri Tin Manzate Prostick	8 oz 2 lbs
Provysol Manzate Prostick	5 oz 2 lbs
Inspire XT Vacciplant Manzate Prostick	7 oz 14 oz 2 lbs
Inspire XT Oxidate 5.0	7 oz 1 %
Delaro Proline Manzate Prostick	11 oz 1.7 oz 2 lbs
Delaro Complete Proline Manzate Prostick	11 oz 1.7 oz 2 lbs

Management of New Highly Tolerant CLS Varieties

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Introduction: 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.

Objective: Genetic tolerance to CLS may be a key tool to controlling this disease. However, these new highly tolerant varieties must be evaluated to determine the best fungicide program to pair with this new tool. The possibility of improving the longevity of current fungicide products with this new tool also must be evaluated.

Materials and Methods: Two trials were conducted as randomized complete blocks with four replications at separate locations. One trial site was located near Clara City, MN and the other trial site was located south of Hector, MN. These trials evaluated three varieties with differing levels of tolerance to CLS (2.0, 3.0, and 4.0 on the KWS rating scale) across six fungicide programs. The varieties used at each location were the same, but the fungicide programs were slightly different (Table 5 and 6). The Clara City Trial was planted on April 24th and the Hector Trial was planted on April 29th. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the sites weed free. The sites were 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 June 28th at Clara City and July 8th at Hector. Fungicide applications began June 30th at Clara City and July 12th at Hector and continued on a ten to twelve-day spray interval. Applications were made using a custom-made tractor mounted sprayer traveling 3.3mph with a spray volume of 20gpa and 60psi, utilizing XR11002 spray nozzles. Each plot consisted of six rows that were 40ft 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 23rd at Clara City and September 10th at Hector using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the lifter 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.

Clara City Trial Results: There were significant differences in the yield parameters between the varieties and between the fungicide programs within a single variety (Table 1). All the 2.0 variety fungicide programs, except the control, had significantly higher extractable sugar per acre (ESA) than all other treatments apart from treatments 8, 14, and 16. Treatments 8 and 14 were the 6 spray fungicide programs for the 3.0 and 4.0 varieties. The 6 spray program for the 3.0 and 4.0 varieties had significantly higher ESA than all other fungicide spray programs for the 3.0 and 4.0 varieties with the exception of treatment 16.

There were significant differences in the foliar disease ratings between the varieties and the fungicide spray programs within varieties (Table 2). The 2.0 variety with a 6 spray program had the lowest foliar disease rating followed by the 3 spray programs in that variety. The 2 spray programs in the 2.0 variety had significantly higher ratings and were similar to the 6 spray programs of the 3.0 and 4.0 varieties. All other treatments had significantly higher ratings and did not provide adequate disease control.

Trt #	Variety	Fungicide Program	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	2	Control	14.4 cde	38.2 de	11.8 cde	236.9 cde	9026.1 c	89.6
2	2	6 Spray Program	15.2 ab	42.8 abc	12.7 abc	254.3 abc	10891.4 ab	90.4
3	2	2 Spray Program(AC)	15.2 ab	44.4 a	12.9 ab	258.2 ab	11230.6 a	91.6
4	2	3 Spray Program (ABC)	15.4 a	44.2 ab	12.9 ab	257.1 ab	11345.9 a	90.0
5	2	3 Spray Program (CDE)	15.2 ab	41.3 abcd	13.0 ab	260.6 ab	10758.8 ab	92.0
6	2	2 Spray Program (CE)	15.2 ab	42.9 abc	12.4 abcd	248.4 abcd	10646.8 ab	88.8
7	3	Control	12.6 h	25.6 i	10.2 f	204.4 f	5226.2 g	89.4
8	3	6 Spray Program	15.5 a	40.5 cd	13.2 a	264.0 a	10671.7 ab	91.5
9	3	2 Spray Program(AC)	13.7 ef	34.8 fg	11.5 de	230.3 de	7948.1 def	91.4
10	3	3 Spray Program (ABC)	14.5 bcd	35.7 ef	12.3 abcd	245.7 abcd	8759.7 cd	91.4
11	3	3 Spray Program (CDE)	13.4 f	32.4 gh	11.2 e	224.4 e	7265.2 f	91.1
12	3	2 Spray Program (CE)	13.9 def	30.3 h	11.6 de	232.7 de	7077.0 f	91.0
13	4	Control	12.6 gh	29.5 h	10.1 f	202.5 f	5967.0 g	88.4
14	4	6 Spray Program	15.3 a	42.4 abc	12.7 abc	254.9 abc	10822.6 ab	90.0
15	4	2 Spray Program(AC)	13.7 ef	38.8 de	11.6 de	232.2 de	9003.1 c	91.7
16	4	3 Spray Program (ABC)	14.9 abc	41.0 bcd	12.4 abcd	248.3 abcd	10174.4 b	90.1
17	4	3 Spray Program (CDE)	14.4 cde	34.5 fg	12.2 bcd	243.3 bcd	8413.0 cde	91.5
18	4	2 Spray Program (CE)	13.3 fg	34.7 fg	11.0 ef	220.8 ef	7643.3 ef	90.3
		Mean	14.4	37.4	12.0	239.8	9032.9	90.5
		CV%	3.6	6.1	5.6	5.6	7.9	1.8
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.0756
		lsd (0.05)	0.73	3.3	0.94	18.8	1011.7	ns

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

Trt #	Variety	Fungicide Program	30-Jul	6-Aug	16-Aug	25-Aug	8-Sep	15-Sep
1	2	Control	1.4 ef	2.0 f	3.0 e	4.4 d	5.7 f	6.8 e
2	2	6 Spray Program	1.1 f	1.1 i	1.1 h	1.1 g	1.1 k	1.2 j
3	2	2 Spray Program(AC)	1.0 f	1.2 hi	1.2 h	1.3 g	2.1 j	3.1 gh
4	2	3 Spray Program (ABC)	1.0 f	1.2 i	1.1 h	1.2 g	1.8 j	2.4 i
5	2	3 Spray Program (CDE)	1.5 ef	1.7 fgh	2.0 fg	2.5 f	2.8 i	2.9 hi
6	2	2 Spray Program (CE)	1.6 e	1.7 fg	2.4 f	2.7 f	3.5 g	3.9 f
7	3	Control	4.6 a	5.5 a	7.9 a	8.8 a	8.8 a	9.0 a
8	3	6 Spray Program	1.3 ef	1.4 ghi	1.7 g	2.6 f	3.0 hi	3.1 gh
9	3	2 Spray Program(AC)	2.6 d	2.7 e	4.2 d	5.6 c	8.0 bc	8.9 ab
10	3	3 Spray Program (ABC)	1.2 ef	1.6 ghi	2.2 fg	3.6 e	6.3 e	8.0 cd
11	3	3 Spray Program (CDE)	4.5 ab	4.8 bc	6.0 bc	7.0 b	6.9 d	6.6 e
12	3	2 Spray Program (CE)	4.3 abc	4.4 dc	5.9 c	7.1 b	7.8 bc	7.9 d
13	4	Control	4.0 bc	5.2 ab	8.2 a	9.0 a	9.0 a	9.0 a
14	4	6 Spray Program	1.3 ef	1.5 ghi	1.9 g	2.6 f	3.4 gh	3.6 fg
15	4	2 Spray Program(AC)	2.1 d	2.6 e	4.3 d	5.4 c	8.2 b	9.0 a
16	4	3 Spray Program (ABC)	1.1 ef	1.4 ghi	2.1 fg	3.3 e	6.1 e	7.8 d
17	4	3 Spray Program (CDE)	4.2 abc	4.7 bc	6.4 b	7.4 b	7.7 c	7.7 d
18	4	2 Spray Program (CE)	3.9 c	4.2 d	5.7 c	7.1 b	8.2 b	8.5 bc
		Mean	2.4	2.7	3.7	4.6	5.6	6.1
		CV%	15.2	12.1	8.3	6.3	5.7	5.5
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
		lsd (0.05)	0.51	0.46	0.44	0.41	0.45	0.47

Table 2: Foliar ratings for the Clara City Trial using the KWS 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.

Hector Trial Results: There were significant differences in the yield parameters between the varieties and between the fungicide programs within a single variety (Table 3). The control and the 2 spray triazole program with the 3.0 and 4.0 varieties had significantly lower ESA than most other treatments. The majority of the treatments did not significantly differ in yield parameters.

There were significant differences in the foliar disease ratings between the varieties and the fungicide spray programs within varieties (Table 4). The 5 spray program and the EBDC alone program had the lowest foliar disease rating when used in combination with the 2.0 variety. The 3 spray programs with the 2.0 variety had slightly higher ratings followed by the 2 spray program with the 2.0 variety and the 5 spray programs for the 3.0 and 4.0 varieties. The EBDC alone program for the 3.0 and 4.0 varieties had significantly lower foliar disease ratings than the 3 spray programs for those varieties. The 3.0 and 4.0 varieties had very similar foliar disease ratings when compared across the same fungicide spray program.

Trt #	Variety	Fungicide Program	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	2	Control	13.9 ab	34.5 abc	11.2 ab	224.3 ab	7734.8 abc	88.3 abcde
2	2	5 Spray Program (0ABCDE)	14.1 a	34.4 abc	11.3 ab	225.6 ab	7724.6 abcd	88.0 abcdef
3	2	3 Spray Tin Program (0ACE)	13.7 ab	34.5 abc	10.8 ab	216.4 ab	7455.5 bcde	87.1 defg
4	2	3 Spray Triazole Program(0ACE)	13.7 ab	33.2 bcd	10.9 ab	217.6 ab	7125.2 de	87.4 cdefg
5	2	2 Spray Triazole Program (BD)	13.9 ab	34.4 abc	11.3 ab	225.9 ab	7778.5 ab	89.0 ab
6	2	EBDC Alone Program (0ABCDE)	13.9 ab	34.6 abc	11.1 ab	221.4 ab	7646.7 bcd	87.5 bcdef
7	3	Control	13.4 bc	24.6 h	10.7 bc	214.4 bc	5275.0 i	88.4 abcd
8	3	5 Spray Program (0ABCDE)	14.0 a	30.4 ef	11.4 ab	227.7 ab	6916.6 ef	88.8 abc
9	3	3 Spray Tin Program (0ACE)	14.1 a	31.6 de	11.6 a	231.0 a	7284.3 bcde	89.4 a
10	3	3 Spray Triazole Program(0ACE)	14.0 a	30.4 ef	11.4 ab	228.7 ab	6940.1 ef	89.0 ab
11	3	2 Spray Triazole Program (BD)	13.9 ab	27.6 g	11.2 ab	222.6 ab	6122.9 gh	87.8 bcdef
12	3	EBDC Alone Program (0ABCDE)	14.0 ab	31.7 de	11.3 ab	225.7 ab	7137.2 cde	88.5 abcd
13	4	Control	12.8 c	28.7 fg	10.0 c	200.3 c	5736.7 hi	87.0 defg
14	4	5 Spray Program (0ABCDE)	14.0 ab	35.1 ab	11.1 ab	222.6 ab	7780.6 ab	87.6 bcdef
15	4	3 Spray Tin Program (0ACE)	13.9 ab	33.6 bcd	10.9 ab	218.3 ab	7291.4 bcde	86.8 efg
16	4	3 Spray Triazole Program(0ACE)	13.9 ab	34.1 bcd	10.9 ab	218.7 ab	7452.8 bcde	86.7 fg
17	4	2 Spray Triazole Program (BD)	13.0 c	32.2 cde	10.0 c	200.1 c	6439.0 fg	85.9 g
18	4	EBDC Alone Program (0ABCDE)	14.2 a	36.7 a	11.3 ab	226.4 ab	8302.5 a	87.4 cdefg
		Mean	13.8	32.33	11.02	220.5	7119	87.8
		CV%	3.2	5.7	4.7	4.7	6	1.2
		Pr>F	0	<.0001	0.0024	0.003	<.0001	0
		lsd (0.05)	0.62	2.6	0.74	14.7	606.1	1.5

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

Trt #	Variety	Fungicide Program	6-Aug	16-Aug	30-Aug	8-Sep
1	2	Control	2.2 c	2.9 c	4.6 d	5.5 e
2	2	5 Spray Program (0ABCDE)	1.3 h	1.4 f	1.3 h	1.5 k
3	2	3 Spray Tin Program (0ACE)	1.3 gh	1.7 ef	1.8 h	2.2 ij
4	2	3 Spray Triazole Program(0ACE)	1.3 gh	1.5 f	2.4 g	2.5 i
5	2	2 Spray Triazole Program (BD)	1.6 fg	2.0 de	3.1 f	3.5 gh
6	2	EBDC Alone Program (0ABCDE)	1.2 h	1.5 f	1.5 h	1.9 jk
7	3	Control	4.0 ab	7.0 a	9.0 a	9.0 a
8	3	5 Spray Program (0ABCDE)	1.8 def	2.2 d	2.5 g	3.1 h
9	3	3 Spray Tin Program (0ACE)	2.2 c	3.0 c	5.1 c	6.0 d
10	3	3 Spray Triazole Program(0ACE)	2.2 cd	2.9 c	5.1 c	6.2 cd
11	3	2 Spray Triazole Program (BD)	3.8 b	4.3 b	7.7 b	8.5 b
12	3	EBDC Alone Program (0ABCDE)	2.3 c	2.2 d	3.9 e	4.9 f
13	4	Control	4.2 a	6.8 a	9.0 a	9.0 a
14	4	5 Spray Program (0ABCDE)	1.8 ef	2.1 d	2.7 fg	3.6 g
15	4	3 Spray Tin Program (0ACE)	2.0 cde	2.9 c	5.3 c	6.4 cd
16	4	3 Spray Triazole Program(0ACE)	2.0 cdef	3.0 c	5.4 c	6.5 c
17	4	2 Spray Triazole Program (BD)	3.8 b	4.5 b	7.5 b	8.5 b
18	4	EBDC Alone Program (0ABCDE)	2.0 cde	2.3 d	4.1 e	5.3 ef
		Mean	2.3	3.0	4.6	5.2
		CV%	11.3	9.8	6.6	6.4
		Pr>F	<.0001	<.0001	<.0001	<.0001
		lsd (0.05)	0.37	0.42	0.42	0.47

Table 4: Foliar ratings for the Hector Trial using the KWS 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.

Conclusion: The genetic yield and quality potential of the varieties tested appear to be similar in the absence of disease. The 2.0 variety clearly does not need the same rigorous fungicide program that the 4.0 variety needs in order maintain a similar extractable sugar per acre in a high disease pressure situation. The 3.0 and the 4.0 varieties had a similar performance in both trials. Based upon the results of the Hector Trial it appears that it may be possible to develop a fungicide spray program that removes one of the currently used fungicide mode of action groups to slow resistance development and improve product performance in the future. However, this will only be possible when a high percentage of the acres planted in the growing area contain the new high level of tolerance to CLS.

These new highly tolerant varieties can be used as another tool to help reduce the impact of CLS and also reduce the cost of fungicide programs. With the results of the trials from 2020 and 2021 it appears that these new highly tolerant varieties should be able to utilize a fungicide spray program with 3 less applications than varieties with a traditional level of CLS tolerance. The number of applications needed to suppress CLS will be dependent on the environmental conditions and inoculum load of a given year. CLS tolerance is only one attribute of a variety and there are many other factors that can impact the yield of a sugar beet field.

Table 5: Clara City Trial treatment list. The application code indicates when the product was applied in the spray program.

Trt #	Variety	Fungicide Program		Rate/Acre	Application Code
1	2	Control	n/a	n/a	n/a
2	2	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABCDEF
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
3	2	2 Spray Program	SuperTin	8 oz	A
			Masterlock	6.4 oz	AC
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	AC
4	2	3 Spray Program	SuperTin	8 oz	AC
			Masterlock	6.4 oz	ABC
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABC
5	2	3 Spray Program	SuperTin	8 oz	CE
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	D
			Manzate Prostick	2 lbs	CDE
6	2	2 Spray Program	SuperTin	8 oz	C
			Masterlock	6.4 oz	CE
			Inspire XT	7 oz	E
			Manzate Prostick	2 lbs	CE
7	3	Control	n/a	n/a	n/a
8	3	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABCDEF
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
9	3	2 Spray Program	SuperTin	8 oz	A
			Masterlock	6.4 oz	AC
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	AC
10	3	3 Spray Program	SuperTin	8 oz	AC
			Masterlock	6.4 oz	ABC
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABC
11	3	3 Spray Program	SuperTin	8 oz	CE
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	D
			Manzate Prostick	2 lbs	CDE
12	3	2 Spray Program	SuperTin	8 oz	C
			Masterlock	6.4 oz	CE
			Inspire XT	7 oz	E
			Manzate Prostick	2 lbs	CE
13	4	Control	n/a	n/a	n/a
14	4	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABCDEF
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
15	4	2 Spray Program	SuperTin	8 oz	A
			Masterlock	6.4 oz	AC
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	AC
16	4	3 Spray Program	SuperTin	8 oz	AC
			Masterlock	6.4 oz	ABC
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABC
17	4	3 Spray Program	SuperTin	8 oz	CE
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	D
			Manzate Prostick	2 lbs	CDE
18	4	2 Spray Program	SuperTin	8 oz	C
			Masterlock	6.4 oz	CE
			Inspire XT	7 oz	E
			Manzate Prostick	2 lbs	CE

Table 6: Hector Trial treatment list. The application code indicates when the product was applied in the spray program.

Trt #	Variety	Fungicide Program		Rate/Acre	Application Code
1	2	Control	n/a	n/a	n/a
2	2	5 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	0ABCDE
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	0ABCDE
			Eminent VP	13 oz	D
3	2	3 Spray Program	SuperTin	8 oz	AE
		(Tin)	Masterlock	6.4 oz	0ACE
			Badge SC	32 oz	C
			Manzate Prostick	2 lbs	0ACE
4	2	3 Spray Program	Proline	5.7 oz	E
		(Early Triazole)	Masterlock	6.4 oz	0ACE
			Badge SC	32 oz	C
			Inspire XT	7 oz	A
			Manzate Prostick	2 lbs	0ACE
5	2	2 Spray Program	Manzate Prostick	2 lbs	BD
		(Late Triazole)	Masterlock	6.4 oz	BD
			Badge SC	32 oz	D
			Inspire XT	7 oz	B
6	2	6 Spray Program	Masterlock	6.4 oz	0ABCDE
		(EBDC only)	Manzate Prostick	2 lbs	0ABCDE
7	3	Control	n/a	n/a	n/a
8	3	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	0ABCDE
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	0ABCDE
			Eminent VP	13 oz	D
9	3	3 Spray Program	SuperTin	8 oz	AE
		(Tin)	Masterlock	6.4 oz	0ACE
			Badge SC	32 oz	C
			Manzate Prostick	2 lbs	0ACE
10	3	3 Spray Program	Proline	5.7 oz	E
		(Early Triazole)	Masterlock	6.4 oz	0ACE
			Badge SC	32 oz	C
			Inspire XT	7 oz	A
			Manzate Prostick	2 lbs	0ACE
11	3	2 Spray Program	Manzate Prostick	2 lbs	BD
		(Late Triazole)	Masterlock	6.4 oz	BD
			Badge SC	32 oz	D
			Inspire XT	7 oz	B
12	3	6 Spray Program	Masterlock	6.4 oz	0ABCDE
		(EBDC only)	Manzate Prostick	2 lbs	0ABCDE
13	4	Control	n/a	n/a	n/a
14	4	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	0ABCDE
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	0ABCDE
			Eminent VP	13 oz	D
15	4	3 Spray Program	SuperTin	8 oz	AE
		(Tin)	Masterlock	6.4 oz	0ACE
			Badge SC	32 oz	C
			Manzate Prostick	2 lbs	0ACE
16	4	3 Spray Program	Proline	5.7 oz	E
		(Early Triazole)	Masterlock	6.4 oz	0ACE
			Badge SC	32 oz	C
			Inspire XT	7 oz	A
			Manzate Prostick	2 lbs	0ACE
17	4	2 Spray Program	Manzate Prostick	2 lbs	BD
		(Late Triazole)	Masterlock	6.4 oz	BD
			Badge SC	32 oz	D
			Inspire XT	7 oz	B
18	4	6 Spray Program	Masterlock	6.4 oz	0ABCDE
		(EBDC only)	Manzate Prostick	2 lbs	0ABCDE

EBDC Synergism Trial

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Introduction: Ethylenebisdiothiocarbamate (EBDC) fungicides are complex products with multiple degradation pathways. These products, along with Proline, are pro-fungicides. Because pro-fungicides need to breakdown to reach the fungicidal compound there is a possibility of improving or hindering the efficacy of these products in reducing disease severity. We have shown that there is likely a synergism between Proline and EBDC. However, it would be beneficial to identify additional products that could induce the same improved efficacy due to label restrictions and best management practices in regard to selection pressure and resistance development.

Objective: Two trials were conducted to screen products that may interact with EBDC or Proline in a synergistic manner. Products used were chosen based upon the degradation process of both EBDC and Proline.

Materials and Methods: These trials were conducted as a randomized complete block with four replications near Hector and Clara City, MN. These trials evaluated different products in combination with EBDC or Proline. The Hector site was planted on April 29th using Crystal M977. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 3.1 lbs./acre of 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 8th. Five fungicide applications were made beginning July 12th and continuing on a ten to twelve-day spray interval. Treatments are shown in Table 5. Manzate Prostick was the EBDC product used in this trial.

The Clara City site was planted on April 24th using Crystal M977. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 2.5 lbs./acre of 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 8th. Six fungicide applications were made beginning June 30th and continuing on a ten to twelve-day spray interval. Treatments are shown in Table 6.

Applications were made using a custom-made tractor mounted sprayer traveling 3.3mph with a spray volume of 20gpa and 60psi, utilizing XR11002 spray nozzles. Each plot consisted of six rows that were 40ft 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 10th for the Hector site and on September 23rd at the Clara City site using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the lifter 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.

Results: While yield and quality data is not the primary parameter that is utilized to compare treatments in CLS trials there were a few significant differences. At the Hector site the check and the manganese sulfate treatments had significantly lower extractable sugar per acre (ESA) than all of the other treatments (Table 3). At the Clara City site, the check had significantly lower ESA than all of the other treatments (Table 1). In addition, the Proline alone, Proline + zinc sulfate, and Proline + manganese sulfate had significantly lower ESA than the Proline + Microthiol Disperss and all of the treatments containing Manzate Prostick.

None of the product combinations tested at either site reduced disease severity similar to the Manzate Prostick + Proline treatment. There were very few new meaningful differences in either of the trials (Tables 2 and 4). At the Clara City site, the Proline + Microthiol Disperss did reduce disease severity significantly compared to the Proline alone.

Conclusion: None of the products tested performed as well as the Proline + Manzate Prostick. However, Microthiol Disperss showed a significant reduction in disease severity when combined with Proline. When it was combined with Manzate Prostick it had a numerically lower rating that Manzate Prostick alone but not significant. Microthiol Disperss is a product that we will continue to investigate as a potential tank-mix partner.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	12.5 d	30.4 e	10.1 c	200.7 c	6101.3 d	88.7
Manzate Prostick	15.3 ab	41.4 bc	12.8 a	256.2 a	10581.6 b	90.6
Proline	14.8 abc	38.7 d	12.5 ab	249.6 ab	9649.8 c	91.1
Proline + Manzate	15.3 ab	44.7 a	12.9 a	258.3 a	11522.0 a	91.1
Proline + Zinc Sulfate	14.3 c	39.2 cd	11.7 b	234.5 b	9193.7 c	89.4
Proline + Mang. Sulfate	14.5 bc	39.3 cd	12.2 ab	244.5 ab	9553.3 c	91.5
Proline + Microthiol Disperss	15.1 abc	41.2 bc	12.7 a	254.4 a	10468.5 b	91.1
Manzate + Microthiol Disperss	15.4 a	41.9 b	13.1 a	261.2 a	10940.5 ab	91.4
Mean	14.6	39.6	12.3	244.9	9751.3	90.6
CV%	4.1	4.2	5.0	5.0	5.7	1.9
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.2362
lsd (0.05)	0.88	2.5	0.90	17.9	812.2	ns

Table 1: Yield parameter results for the EBDC Synergism Trial at the Clara City location. Values with different letters are significantly different.

Treatment	30-Jul	6-Aug	16-Aug	25-Aug	8-Sep	15-Sep
Control	4.5 a	5.4 a	8.2 a	8.9 a	9.0 a	9.0 a
Manzate Prostick	1.5 c	1.9 d	3.2 d	4.0 e	5.1 e	5.8 e
Proline	2.1 b	2.4 bc	4.1 bc	5.1 c	6.7 bc	7.5 bc
Manzate + Proline	1.2 d	1.4 e	1.4 e	1.5 f	2.0 f	2.2 f
Proline + Zinc Sulfate	2.0 b	2.6 b	4.3 b	5.7 b	7.0 b	7.8 b
Proline + Mang. Sulfate	2.0 b	2.3 c	3.9 c	4.7 cd	6.4 cd	7.2 cd
Proline + Microthiol	1.9 b	2.2 c	3.7 c	4.6 d	6.1 d	6.8 d
Manzate + Microthiol	1.6 c	1.8 d	3.0 d	3.8 e	4.8 e	5.4 e
Mean	2.1	2.5	4.0	4.8	5.9	6.4
CV%	8.0	9.5	6.5	5.0	5.2	5.6
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.24	0.35	0.38	0.35	0.45	0.53

Table 2: Foliar ratings for the EBDC Synergism Trial at the Clara City location using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. These ratings are an average of 5 raters from SMBSC.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	13.1 c	28.1 cd	10.2 c	203.8 c	5703.9 b	86.5
Manzate Prostick	14.0 ab	33.9 ab	11.1 ab	222.4 ab	7501.9 a	87.3
Proline	14.0 ab	33.9 ab	11.3 a	224.8 ab	7590.4 a	88.1
Proline + Manzate	14.1 ab	33.8 ab	11.2 ab	224.2 ab	7583.7 a	87.4
Proline + Zinc Sulfate	14.2 a	31.2 bc	11.5 a	229.4 a	7163.0 a	88.3
Proline + Mang. Sulfate	14.2 a	32.8 ab	11.4 a	228.2 a	7468.2 a	88.2
Proline + Ultra Che Zinc	14.0 ab	31.3 bc	11.1 ab	222.4 ab	6964.8 a	87.4
Proline + Ultra Che Mang.	14.4 a	30.9 bc	11.6 a	231.6 a	7157.1 a	88.0
Proline + Amsol Dry AMS	13.4 bc	33.4 ab	10.5 bc	209.8 bc	7014.3 a	86.8
Manzate + Amsol Dry AMS	14.1 ab	35.0 a	11.2 ab	223.1 ab	7792.5 a	87.2
Manganese Sulfate	12.7 c	27.0 d	9.9 c	197.0 c	5321.8 b	86.6
Manzate + Mang. Sulfate	13.8 ab	32.4 ab	11.1 ab	221.0 ab	7181.1 a	87.7
Mean	13.8	32.0	11.0	219.8	7036.9	87.5
CV%	3.7	7.7	4.9	4.9	8.7	1.2
Pr>F	0.0007	0.0012	0.0009	0.001	<.0001	0.1737
lsd (0.05)	0.73	3.5	0.77	15.3	883.0	ns

Table 3: Yield parameter results for the EBDC Synergism Trial at the Hector location. Values with different letters are significantly different.

Treatment	6-Aug	16-Aug	30-Aug	8-Sep
Control	4.0 a	6.4 a	8.9 a	9.0 a
Manzate Prostick	1.5 bc	1.7 gf	3.3 d	4.1 d
Proline	1.7 b	2.3 c	4.2 b	5.3 b
Manzate + Proline	1.2 c	1.5 g	1.6 e	2.3 e
Proline + Zinc Sulfate	1.8 b	2.2 cd	3.9 bc	5.0 b
Proline + Mang. Sulfate	1.4 bc	2.1 cde	3.7 bcd	5.3 b
Proline + Ultra Che Zinc	1.6 b	2.1 cde	4.0 bc	5.2 b
Proline + Ultra Che Mang.	1.6 b	2.3 c	3.7 bcd	5.3 b
Proline + Amsol Dry AMS	1.6 b	2.1 cde	3.6 cd	5.2 b
Manzate + Amsol Dry AMS	1.5 bc	1.9 ef	3.1 d	4.3 cd
Manganese Sulfate	3.8 a	5.9 b	8.8 a	8.9 a
Manzate + Mang. Sulfate	1.5 bc	1.9 def	3.6 cd	4.5 c
Mean	1.9	2.7	4.4	5.4
CV%	13.0	7.6	9.2	5.1
Pr>F	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.36	0.29	0.58	0.39

Table 4: Foliar ratings for the EBDC Synergism Trial at the Hector location using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. These ratings are an average of 5 raters from SMBSC.

Trt #	Treatment	Application Rate/Acre
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
	Zinc Sulfate	3 oz
	Masterlock	6.4 oz
6	Proline	5.7 oz
	Manganese Sulfate	1.5 lbs
	Masterlock	6.4 oz
7	Proline	5.7 oz
	Ultra Che Zinc	7 oz
	Masterlock	6.4 oz
8	Proline	5.7 oz
	Ultra Che Mang.	50 oz
	Masterlock	6.4 oz
9	Proline	5.7 oz
	Amsol Dry AMS	3 lbs
	Masterlock	6.4 oz
10	Manzate Prostick	2 lbs
	Amsol Dry AMS	2 oz
	Masterlock	6.4 oz
11	Manganese Sulfate	5 lbs
	Masterlock	6.4 oz
12	Manzate Prostick	2 lbs
	Manganese Sulfate	1.5 lbs
	Masterlock	6.4 oz

Table 5: EBDC Synergism Hector Trial treatment list.

Trt #	Treatment	Application Rate/Acre
1	Check	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
	Zinc Sulfate	3 oz
	Masterlock	6.4 oz
6	Proline	5.7 oz
	Manganese Sulfate	1.5 lbs
	Masterlock	6.4 oz
7	Proline	5.7 oz
	Microthiol Disperss	1 lb
	Masterlock	6.4 oz
8	Manzate Prostick	2 lbs
	Microthiol Disperss	1 oz
	Masterlock	6.4 oz

Table 6: EBDC Synergism Clara City Trial treatment list.

Nitrogen Rate Trials for 2021

John A. Lamb[1], David Mettler[2], and Mark Bloomquist[3]
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[2]Research Agronomist, and [3]Research Director, SMBSC, Renville, MN

Introduction: Nitrogen management is a top priority for production of high-quality sugar beet. With the continued changes in sugar beet production practices, it is important to continue to update N fertilizer guidelines with new information.

Objective: Provide current N fertilizer guidelines for sugar beet production in the Southern Minnesota Beet Sugar Cooperative growing area.

Methods and Materials: In 2021, two locations in the Southern Minnesota Beet Sugar Cooperatives growing area had studies with a N fertilizer rate component to them. One location near Renville, MN and the other near Hector, MN. Fall soil samples were taken for each location prior to the study. The results are reported in Table 1. The soil nitrate-N to a depth of four feet was low at each location, 55 lb N/A and 45 lb N/A at Renville and Hector, respectively. The N fertilizer rates were 0, 30, 60, 90, 120, 150, 180, and 210 lb N/A. There were six replications of the N rates at the Renville location and eight replications of the N rates at the Hector location. The fertilizer N source was urea applied and incorporated prior to planting. Stand counts were taken after emergence. The locations were harvested by machine in October and quality samples were taken at that time. Quality was determined in the Southern Minnesota Beet Sugar Cooperative tare lab.

Table 1. Soil test results for Renville and Hector locations in 2021.

Soil test	Renville	Hector
Soil nitrate-N 0-4 ft. (lb N/A)	55	45
Olsen -P 0-6 in. (ppm)	3	7
K 0-6 in. (ppm)	166	125
pH 0-6 in. (unitless)	8.0	7.7
Organic matter 0-6 in. (%)	6.7	2.9

Results: The 2021 growing season was droughty up to mid-August and then significant precipitation occurred at each site. The average root yield was 43.4 tons/A and the average sucrose was 16.6 % at the Renville location and 40.0 tons/A and 14.8 % at the Hector location.

Renville Results: The addition of N fertilizer significantly affected root yield and extractable sucrose per acre at the Renville location in 2021, Table 2, Figures 1, 2, and 3. Extractable sucrose per ton was not significantly affected by N application. The response for root yield and extractable sucrose per acre was a quadratic plateau. Root yield was optimized at 191 lb soil test nitrate-N plus fertilizer N (0 to 4 feet) with a plateau at 44.4 tons/A, Figure 1. Extractable sucrose per ton was not affected by the addition of fertilizer N. Normally the application of N fertilizer reduces extractable sucrose per ton, Figure 2. Extractable sucrose per acre response at the Renville site was maximized at 117 lb soil test nitrate-N plus fertilizer N/A, Figure 3. The soil test nitrate-N was low and a positive response for root yield and extractable sucrose per acre was expected. The 117 lb/A is well within the current N suggestions for optimum extractable sucrose per acre.

Table 2. The effect of nitrogen on root yield, extractable sucrose per ton, and extractable sucrose per acre at the Renville location in 2021.

Soil test nitrate-N plus fertilizer N	N rate	Root yield	Extractable sucrose per ton	Extractable sucrose per acre
lb N/A	lb N/A	ton/A	lb/ton	lb/A
55	0	38.4	275	10599
85	30	41.7	286	11950
115	60	44.1	284	12495
145	90	44.0	280	12311
175	120	43.4	276	11944
205	150	45.7	281	12891
235	180	46.0	278	12813
265	210	43.9	271	12120
Statistics	N rate	0.02	0.68	0.03
	C.V.	7.9	4.7	9.0
	Mean	43.4	279	12141

Hector Results: The addition of N fertilizer at the Hector location did significantly affect the root yield, extractable sucrose per ton, and the extractable sucrose per acre, Table 3, Figures 1, 2, and 3. This was expected as the soil test nitrate-N to a depth of four feet was 45 lb N/A. Root yield was optimized at 40.4 tons/A with 145 lb soil test nitrate-N plus fertilizer N/A, Figure 1, while the optimum extractable sucrose per acre was with 93 lb soil test nitrate-N plus fertilizer N/A, Figure 3. Extractable sucrose per ton was reduced with the addition of fertilizer N, Figure 2. The reduction was linear with the greatest extractable sucrose at 250 lb/ton with 0 lb N/A applied and reducing to 236 lb/ton with the 210 lb N/A application.

Table 3. The effect of nitrogen on root yield, extractable sucrose per ton, and extractable sucrose per acre at the Hector location in 2021. (Data provided by Dan Kaiser U of MN)

Soil test nitrate-N plus fertilizer N	N rate	Root yield	Extractable sucrose per ton	Extractable sucrose per acre
lb N/A	lb N/A	ton/A	lb/ton	lb/A
45	0	33.1	250	8282
75	30	39.5	247	9723
105	60	38.2	249	9520
135	90	43.0	249	10677
165	120	40.2	244	9789
195	150	41.2	231	9516
225	180	43.0	237	10019
255	210	42.9	236	10253
Statistics	N rate	0.0001	0.0009	0.0001
	C.V.	7.4	4.0	7.0
	Mean	40.0	243	9704

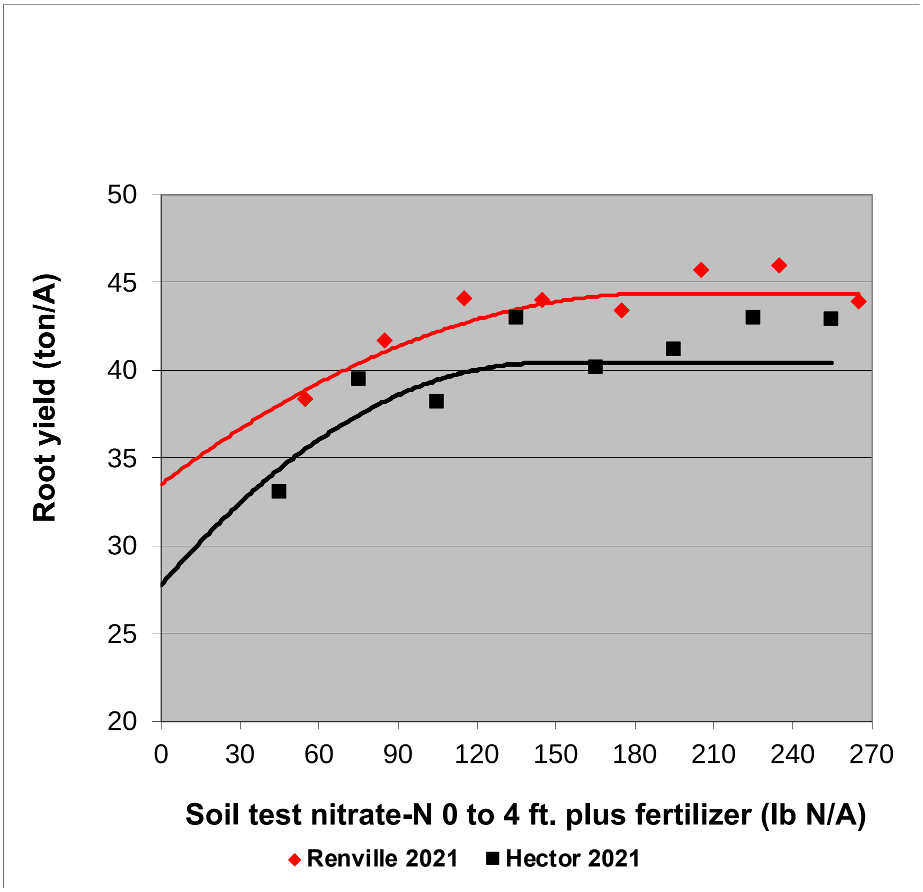

Figure 1. Root yield at Renville and Hector as affected by soil test nitrate-N (0-4 feet) plus fertilizer N in 2021.

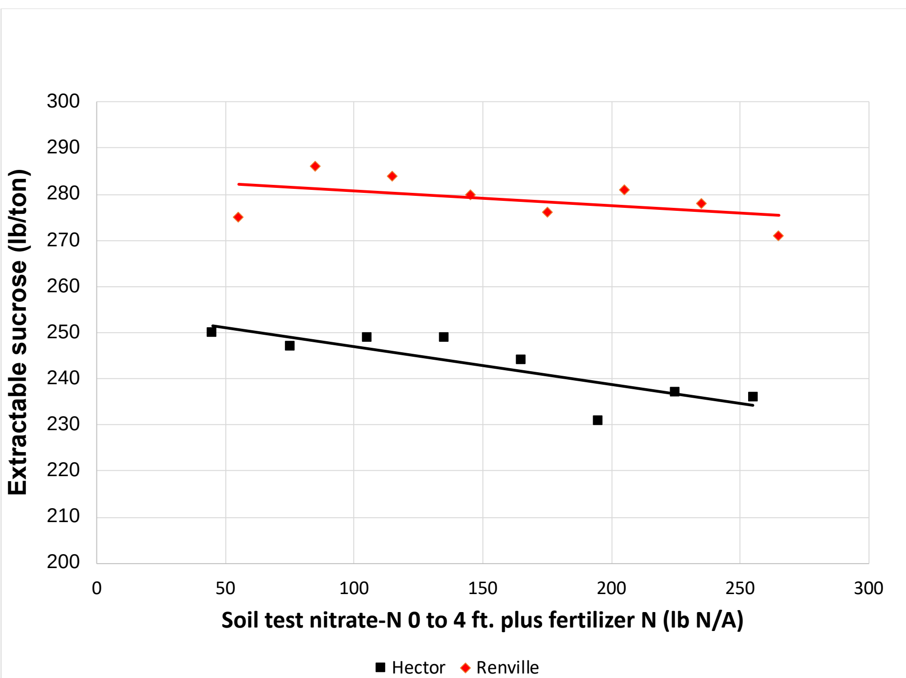

Figure 2. Extractable sucrose per ton at Renville and Hector as affected by soil test nitrate-N (0-4 feet) plus fertilizer N in 2021.

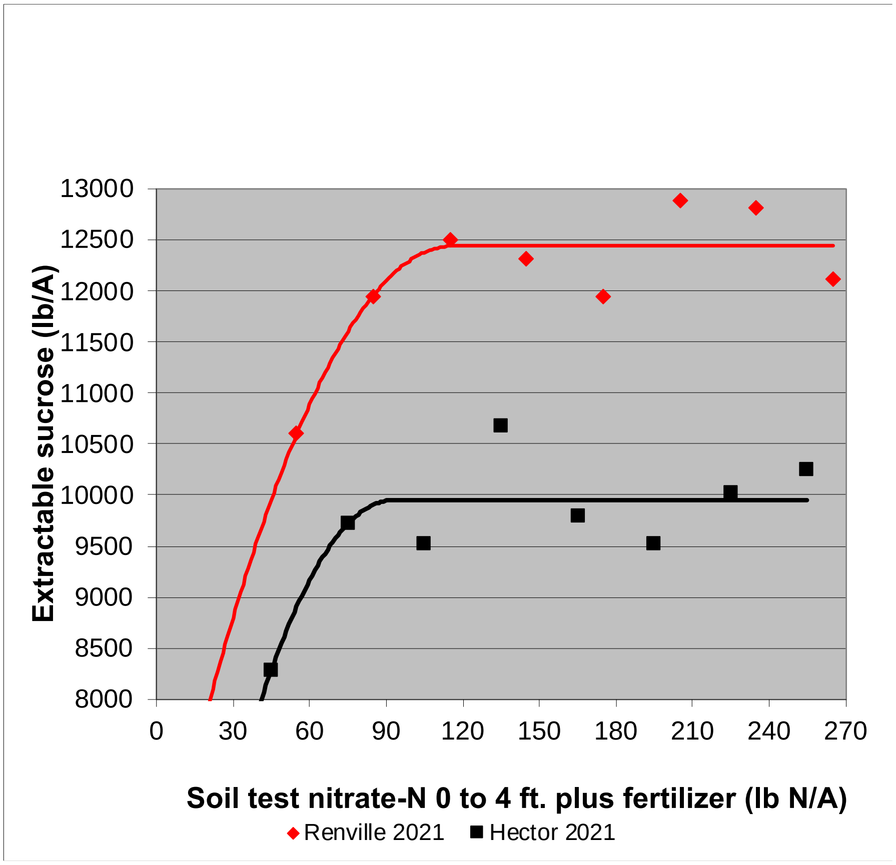

Figure 3. Extractable sucrose per acre at Renville and Hector as affected by soil test nitrate-N (0-4 feet) plus fertilizer N in 2021.

Conclusion: The responses to N application occurred for root yield and extractable sucrose per acre at both locations in 2021. The optimum soil test nitrate-N plus fertilizer N level was 191 lb N/A for root yield and 117 lb N/A for extractable sucrose per acre at the Renville location. The optimum soil test nitrate-N plus fertilizer N was 145 lb N/A for root yield and 93 lb N/A for extractable sucrose per acre at the Hector location in 2021. Extractable sucrose per ton was reduced by N application at the Hector site and not affected at Renville.

What does this mean for the N fertilizer guideline currently used? This guideline is based on many locations of data over the years. Because the information for both sites in 2021was a positive and significant response to added N fertilizer, the data from these sites will be added to the database. Current guidelines based on research from 2010 to 2021 indicate that the optimum extractable sucrose per acre can be achieved with 117 lb N/A as soil test nitrate-N to a depth of four feet plus fertilizer N with N fertilizer cost of $0.75 per lb N and sugar price at $0.17 per lb.

Potassium by Nitrogen Rate Trial

David Mettler[1], and Mark Bloomquist[2], and John A. Lamb[3],
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[3]Professor Emeritus University of Minnesota, St. Paul, MN

Introduction: Nitrogen management is a top 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 varied levels of nitrogen.

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

Materials and Methods: This trial was conducted as a 3 x 5 factorial with four replications following field corn south of Hector, MN. Soil samples were taken in the spring prior to treatment application (Table 1). The nitrogen fertilizer rates were 0, 95, and 165 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 using SES 863 with 3 gallons of 10-34-0 in-furrow at planting. Dual Magnum was applied as a pre emerge and 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 September 29th using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the lifter 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 Hector location from spring soil sample in 2021.

Soil test	Hector
Soil nitrate-N 0-4 ft. (lb N/A)	76
Olsen -P 0-6 in. (ppm)	4
K 0-6 in. (ppm)	168
pH 0-6 in. (unitless)	7.7
Organic matter 0-6 in. (%)	4.7

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 root yield but had a negative impact on beet quality (Table 3 and Figure 1). There was a significant interaction between potassium and nitrogen for tons per acre (TPA) and extractable sucrose per acre (ESA). However, potassium application did not affect TPA or ESA at any of the nitrogen rates. The nonresponse of potassium was slightly different between the 165lb nitrogen rate and the other rates causing an interaction in the analysis.

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

TRT	Percent Sugar	Tonsperacre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
K-0	15.4	37.0	12.6	252.6	9318.8	89.3
K-30	15.4	36.9	12.6	252.7	9300.1	88.9
K-60	15.7	38.0	12.9	258.6	9786.1	89.4
K-90	15.6	37.3	12.8	256.5	9564.9	89.3
K-120	15.5	38.0	12.8	255.4	9686.5	89.2
Mean	15.5	37.42	12.7	255.0	9540.8	89.2
CV%	3.7	7.0	4.9	4.9	8.1	1.2
Pr>F	0.72	0.75	0.73	0.75	0.45	0.86
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.

TRT	Percent Sugar	Tonsperacre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
N-0	15.8 a	32.8 b	13.1 a	261.9 a	8611.4 b	89.8 a
N-95	15.5 ab	39.8 a	12.7 ab	254.8 ab	10135.6 a	89.2 ab
N-165	15.2 b	39.6 a	12.4 b	248.8 b	9846.7 a	88.7 b
Mean	15.5	37.42	12.7	255.0	9540.8	89.2
CV%	3.7	7.0	4.9	4.9	8.1	1.2
Pr>F	0.0273	<.0001	0.007	0.0093	<.0001	0.011
lsd (0.05)	0.36	1.68	0.395	8.0	496.1	0.679

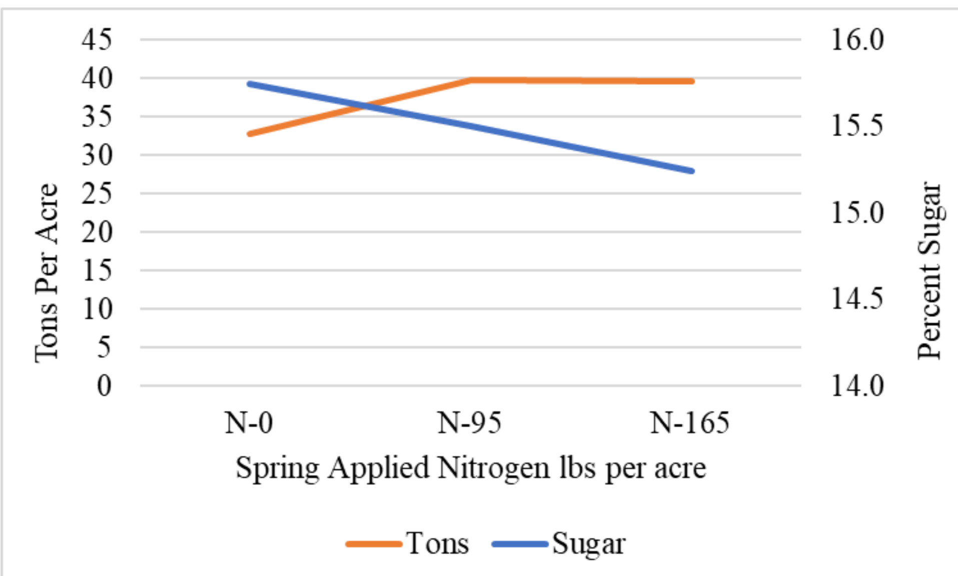

Figure 1: The effect of fertilizer N on tons and percent sugar.

Conclusion: 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 increasing potassium rates as nitrogen rates increase does not have any impact. However, this trial did reaffirm that increasing nitrogen rates beyond sufficiency levels can have a negative impact on the quality of the sugar beet crop and result in less extractable sugar per acre.

Soil Fertility for Corn Grown after Unharvested Sugar Beets

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Introduction: The goal of SMBSC is to optimize the sugar refinery's capacity. To do this the grower's goal is to raise enough high quality sugar beets to meet the needs of the refinery. Some years this may mean some 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, and 2021 to answer the objective. The study was located near the SMBSC factory in Renville, MN in 2018, near the Murdock piling site in 2020 and near Cosmos, MN in 2021. In 2017, 2019, and 2020 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. 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. 7 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 while the 2020 site was machine harvested on November 4, 2020. The 2021 site was hand harvested on September 30, 2021.

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

2018 Results: The corn yields were variable because of the very wet weather experienced in 2018. The statistics and corn yields are reported in Tables 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. Nitrogen 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 recommend N rate. Additional N was 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 Results: The corn yields were good because of the ideal weather experienced in 2020. The statistics and corn yields are reported in Table 2 and Table 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. The use of additional 40 lb N/acre fertilizer above the recommended 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 amount 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 Results: The corn grain yields were poor because of droughty conditions during the summer of 2021. The statistics and corn yields are reported in Table 2 and Table 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 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 amount 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.

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

				Grain yield 15.5 % (bu/A)		
Treatment	Beets	Starter	N rate	2018	2020	2021
1.	Not harvested	none	0	84	107	55
2.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0	69	126	61
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
4.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)	173	234	112
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
6.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended +80 N/A (235 lb N/A)	242	241	129
7.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)	215	251	142
8.	Harvested	None	0	101	150	90
9.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0	115	160	99
$LSD_{0.05}$				47	21	12
Grand mean				149	196	102
Trt				0.0001	0.0001	0.0001
Harvest vs No harvest				0.02	0.0001	0.0001
Starter vs No starter				0.99	0.07	0.09
0 N vs Recommended				0.0001	0.0001	0.0001
C.V. %				21.6	7.2	8.3

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, and 2021.

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

Combined Analysis: In the combined statistical analysis across all years, there was an interaction by treatments and year for corn grain yield. This interaction is because of magnitude of grain yield response for the use of starter and the response of 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.

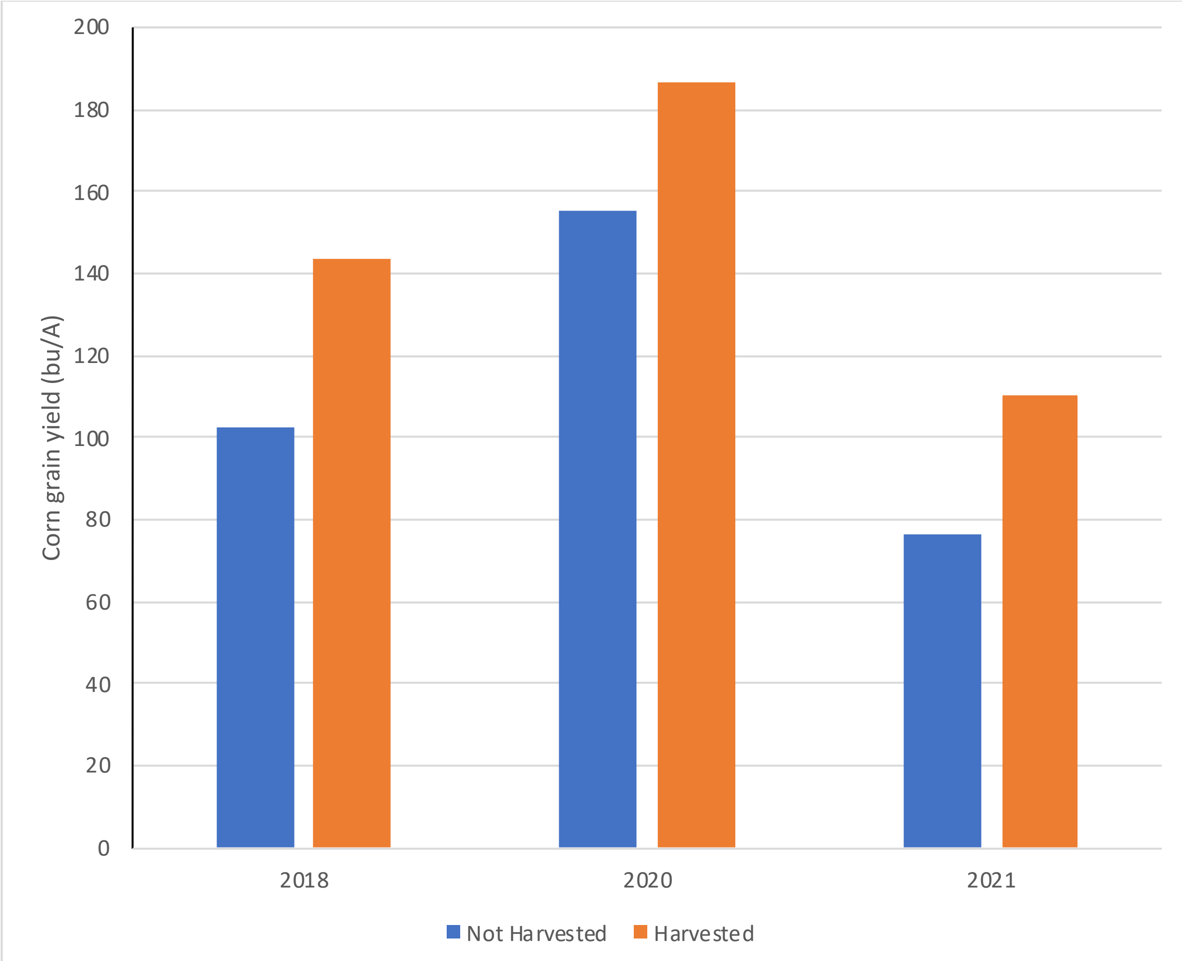

Figure 1. The effect on corn grain yield after sugar beet production with the sugar beet root not harvested or harvested in 2018, 2020, and 2021.

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 this study, Figure 2. While using starter is a good practice in this situation it did not help.

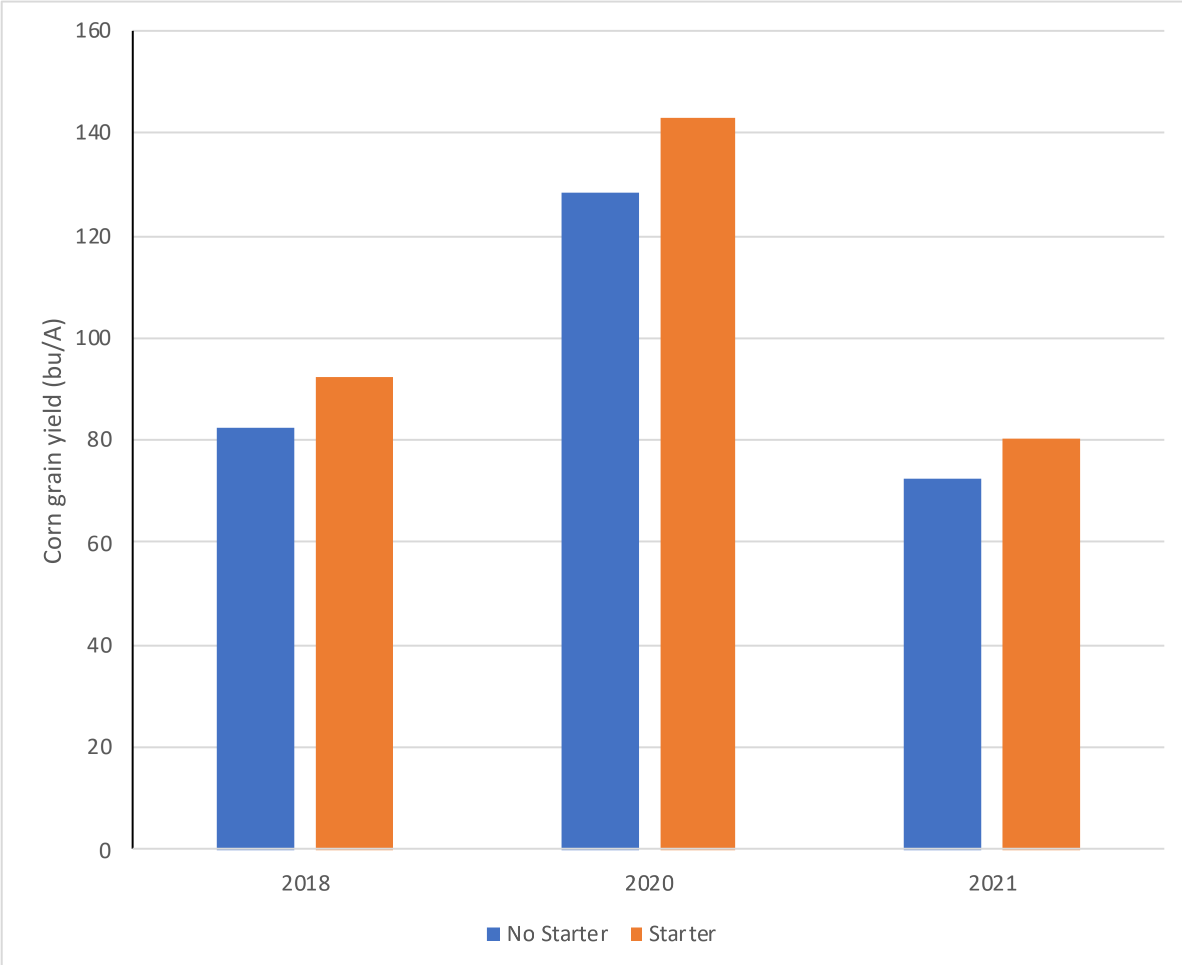

Figure 2. The effect of starter fertilizer (10-34-0 plus Zn) on corn grain yield grown on ground where the previous sugar beet roots were not harvested in 2018, 2020, and 2021.

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 and 2021, 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 was applied.

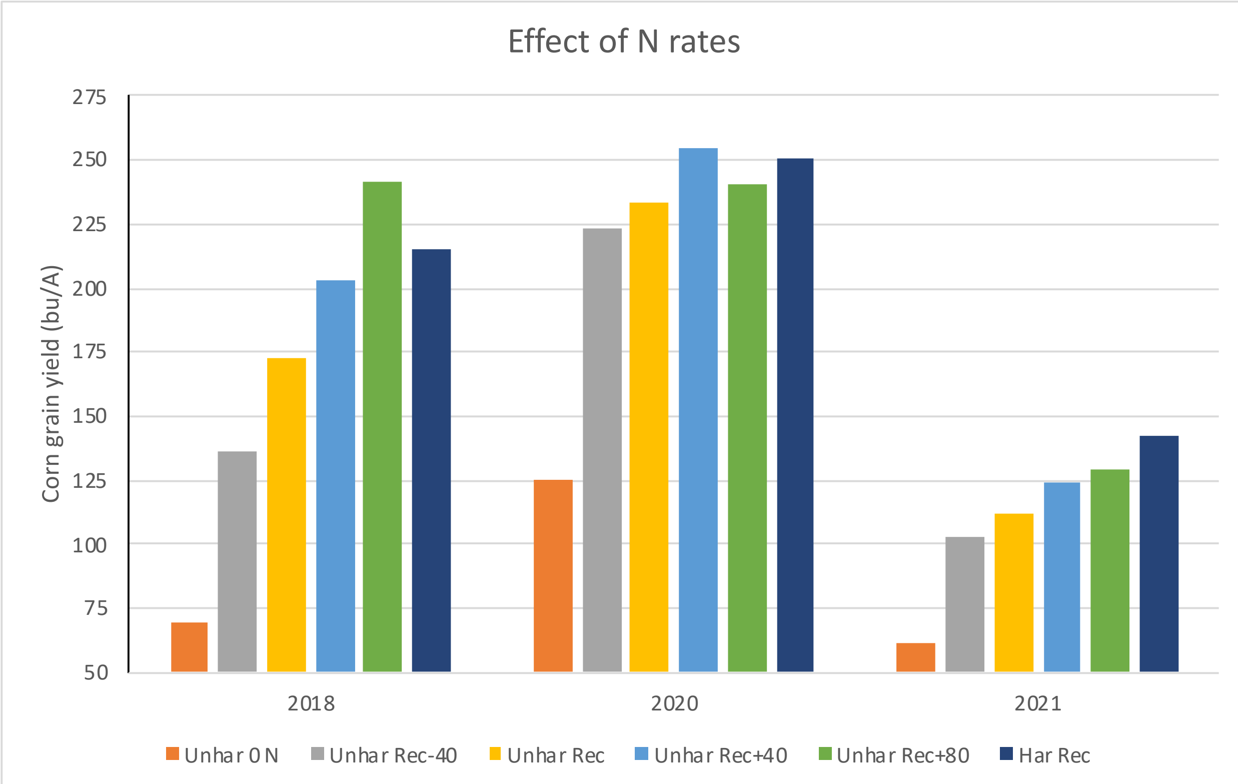

Figure 3. The effect on corn grain yield of added N fertilizer when grown on ground where the previous sugar beet roots were not harvested, 2018, 2020, and 2021.

Conclusion: This study was conducted in three very different climates. The climate was very wet in 2018. In 2020, moisture was ideal for producing high corn grain yields while in 2021, dry conditions reduced the corn grain yield. 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, corn grain yields from the ground where the 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 area. In 2021, the corn grain yields in the not harvested area were not as good as the corn grain yields from the harvested area. 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 conditions slowed both the corn growth and the microbial activity so the extra N applied could not overcome the tie up of soil N.

Sugar Enhancement Trial

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Introduction: 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.

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.

Materials and Methods: A trial was conducted near Renville to screen several products that may have the ability to improve sugar content. The trial was planted on April 22nd using SV863. 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 ten treatments (Table 1). Plots in this trial were six rows wide with the center 4 rows being treated and the center two rows being harvested for yield and quality analysis. The 4 leaf treatments were applied on May 26th using a bike sprayer with XR11002 nozzles with a spray volume of 17gpa. The 8 leaf and the 12 leaf treatments were applied on June 4th and June 15th respectively, using the same sprayer equipment. The center two rows of each six row plot were harvested on October 11th using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the lifter 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.

Results: No significant differences were found in the yield parameters other than purity (Table 2). None of the products tested performed statistically better than the check. These are results from a one year study with a limited number of entries. Further testing may need to be done to see if there is a product that could significantly improve the sugar content of beets in the SMBSC growing area.

Treatment	Description	Timing
1	Check (110lbs Total N)	Preplant
2	Additional Urea (40lbs N)	Preplant
3	Orbix (32oz)	8 leaf and 12 leaf
4	Generate (16oz)	4 leaf and 12 leaf
5	Foliar Essentials 2-1-1 (2gal)	4 leaf, 8 leaf, and 12 leaf
	PRO 10-4-5 (3gal)	12 leaf
6	Photo N (16oz)	4 leaf
7	FP-20 Early (2gal)	8 leaf
8	FP-20 Late (2gal)	12 leaf
9	Ascend SL (10oz)	4 leaf and 8 leaf
10	Voyagro/ZMB+ (32oz/64oz)	4 leaf and 8 leaf

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

Treatment	Percent Sugar	Tons Per Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	17.2	44.9	14.5	289.5	13007.3	90.2 abc
2	16.3	47.5	13.5	270.8	12827.4	89.4 bcd
3	16.8	47.7	14.0	280.7	13388.2	90.1 abcd
4	17.2	46.7	14.5	289.7	13538.5	90.2 abc
5	16.8	45.4	13.8	276.6	12549.8	88.9 d
6	17.0	44.5	14.0	280.8	12510.7	89.2 cd
7	17.1	44.6	14.4	288.1	12842.5	90.5 ab
8	16.9	47.0	14.3	286.1	13451.7	90.9 a
9	16.7	45.9	13.9	278.0	12725.7	89.6 bcd
10	16.9	45.9	14.1	281.4	12925.9	89.6 bcd
Mean	16.9	46.0	14.1	282.2	12976.8	89.9
CV%	2.9	5.3	3.5	3.5	5.9	0.9
Pr>F	0.3651	0.5375	0.1698	0.1681	0.5215	0.0398
lsd (0.05)	ns	ns	ns	ns	ns	1.1

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

CONTROLLING WATERHEMP ESCAPES IN SUGARBEET

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Summary

1. Ultra Blazer broadcast applied, Liberty or Gramoxone applied with the hooded sprayer, or inter-row cultivation at the 10- to 12-lf sugarbeet stage all improved escaped waterhemp control compared with ethofumesate preemergence (PRE) banded followed by repeat (3x) glyphosate plus ethofumesate applications at Blomkest and Moorhead in 2020 and 2021.
2. Treatment at the 10- to 12-lf sugarbeet stage complemented herbicide applications applied at the PRE, 2- to 4-lf, and 6- to 8-lf sugarbeet stage.
3. Apply chloroacetamide herbicide mixtures with glyphosate and ethofumesate at the 2- to 4-lf sugarbeet stage, even when following ethofumesate PRE.

Introduction

Sugarbeet growers use layered application of soil residual herbicides applied preemergence (PRE), early postemergence (EPOST), and postemergence (POST) to manage waterhemp in sugarbeet. These herbicides control waterhemp only after they are incorporated into the soil by rainfall. Soil residual herbicides do not control emerged weeds or weed escapes and must be addressed with the POST portion of a weed management program. Escaped waterhemp control is challenging since we currently do not have a POST herbicide effective for control of glyphosate-resistant waterhemp in sugarbeet.

We evaluated a series of 'ideas' to control waterhemp escapes in sugarbeet including inter-row applications of Liberty with the Redball™ 915 hooded sprayer (24c) and inter-row cultivation in 2020 as well as inter-row applications of Liberty or Gramoxone (not approved in sugarbeet) with the Redball™ 915 hooded sprayer, inter-row cultivation, and Ultra Blazer (Section 18) in 2021. The objective of these experiments was to evaluate sugarbeet tolerance and control of escaped glyphosate-resistant waterhemp using these alternative weed control methods.

Materials and Methods

Experiments were conducted on natural populations of waterhemp in a sugarbeet grower's field near Blomkest, MN in 2020 and 2021 and on our research farm near Moorhead, MN in 2020. The experimental area was prepared for planting by applying the appropriate fertilizer and conducting tillage across the experimental area at each location. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.5 inch spacing between seeds.

Herbicide treatments were designed to create waterhemp escapes in plots that would then be treated at the 10- to 12-leaf sugarbeet stage. Herbicide treatments were ethofumesate PRE broadcast or PRE band-applied followed by Dual Magnum mixtures with Roundup PowerMax plus ethofumesate POST applied at the 2-4 and 6-8 sugarbeet leaf stage. Preemergence broadcast and POST treatments were applied with a bicycle sprayer in 17 gpa spray solution through TeeJet 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. Preemergence band treatments were applied in 11-inch strips over the center four rows of six row plots with a bicycle sprayer in 17 gpa spray solution through TeeJet 4002E nozzles pressurized with CO_2 at 40 psi.

Treatment for control of waterhemp escapes were applied at the 10- to 12-leaf sugarbeet stage and included: a) inter-row cultivation performed using a modified Alloway 3130 cultivator (Alloway Standard Industries, Fargo, ND) with 15-inch sweep shovels with a ground depth of 1.5- to 2-inch at 4 mph; b) inter-row application of Liberty or Gramoxone through TeeJet 8002 EVS nozzles pressurized with CO_2 at 40 psi with the Redball™ 915 hooded sprayer (Willmar Fabrication, LLC, Benson, MN) and c) broadcast application of Ultra Blazer applied with a bicycle sprayer in 17 gpa spray solution through TeeJet 8002 XR-flat fan nozzles pressurized with CO_2 at 40 psi. Herbicide treatments for 2020 experiment at Blomkest and Moorhead are found in Table 1 and herbicide treatments for the 2021 experiment at Blomkest are found in Table 2.

The Moorhead location was harvested in 2020. Sugarbeet were defoliated and the center two or three rows of each plot was harvested mechanically and weighed. Experimental design was randomized complete block with four replications. About a 20 lb. root sample was collected from each plot and analyzed for sucrose content and sugar loss to molasses by American Crystal Sugar Company (East Grand Forks, MN). Data from all experiments were analyzed with the ANOVA procedure of ARM, version 2021.2 software package.

Table 1. Herbicide treatment, herbicide rate, application method and application timing in 2020, Blomkest and Moorhead, MN.

Herbicide Treatment	Rate (fl oz/A)	Application timing (SGBT leaf stage)
Ethofumesate (broadcast) / Roundup PowerMax[1] + ethofumesate / Roundup PowerMax + ethofumesate	96 / 28 + 4 / 28 + 4 / 22 + 4	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Roundup PowerMax + ethofumesate / Roundup PowerMax + ethofumesate	48 / 28 + 4 / 28 + 4 / 22 + 4	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Liberty[3] Hooded sprayer	48 / 16 + 32 + 12 / 32	PRE / 4 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Liberty Hooded sprayer	48 / 16 + 32 + 12 / 32	PRE / 8 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Inter-row cultivation	48 / 16 + 32 + 12 / mechanical	PRE / 4 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Inter-row cultivation	48 / 16 + 32 + 12 / mechanical	PRE / 8 lf / 10-12 lf

[1]Roundup PowerMax + ethofumesate was applied with Destiny HC @ 1.5 pt/A + Amsol Liquid AMS at 2.5% v/v.
[2]Ethofumesate applied using a banded application.
[3]Liberty applied with Dry AMS at 3 lb/A.

Table 2. Herbicide treatment, herbicide rate, application method and application timing in 2021, Blomkest, MN.

Herbicide Treatment	Rate (fl oz/A)	Application timing (SGBT leaf stage)
Ethofumesate (broadcast) / Roundup PowerMax[1] + ethofumesate / Roundup PowerMax + ethofumesate	48 / 28 + 4 / 28 + 4 / 22 + 4	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Roundup PowerMax + ethofumesate / Roundup PowerMax + ethofumesate	48 / 28 + 4 / 28 + 4 / 22 + 4	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Liberty[3] Hooded sprayer	48 / 16 + 28 + 6 / 16 + 28 + 6 / 38	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Gramoxone 3.0 SL Hooded sprayer	48 / 16 + 28 + 6 / 16 + 28 + 6 / 24	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Inter-row cultivation	48 / 16 + 28 + 6 / 16 + 28 + 6 / mechanical	PRE / 4 lf / 8 lf / 10-12 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax[4]	48 / 16 + 28 + 6 / 16 + 28 + 6 / 16 + 22	PRE / 4 lf / 8 lf / 10-12 lf

[1]Roundup PowerMax + ethofumesate was applied with Destiny HC @ 1.5 pt/A + Amsol Liquid AMS at 2.5% v/v.
[2]Ethofumesate applied using a banded application.
[3]Liberty applied with Dry AMS at 3 lb/A.
[4]Ultra Blazer + Roundup PowerMax applied with Prefer 90 NIS @ 0.25% v/v + Amsol Liquid AMS at 2.5% v/v.

Results

Dual Magnum plus Roundup PowerMax and ethofumesate applied at the 2- to 4-lf stage provided waterhemp control greater than Dual Magnum plus Roundup PowerMax and ethofumesate applied at the 6- to 8-lf stage at Blomkest and Moorhead in 2020 (data not presented). Both treatments followed ethofumesate PRE in an 11-inch band at 6 pt/A in the treated area.

Results will focus on control of escaped waterhemp with inter-row cultivation, Roundup PowerMax mixed with ethofumesate, and inter-row application of Liberty with the hooded sprayer at the 10- to 12-lf stage. These POST treatments followed either ethofumesate PRE (broadcast or in a band application) and repeat applications of Roundup PowerMax plus ethofumesate, or ethofumesate PRE in a band followed by Dual Magnum plus Roundup PowerMax and ethofumesate applied at the 2- to 4-lf stage.

We observed sugarbeet injury ranging from 5% to 18%, 39 days after planting (DAP) at Blomkest in 2020 (Table 3). Injury was random within plots and seemed to be related to field variation caused by dry soil conditions; not herbicide treatment. Waterhemp control was greater than 85% across treatments at 47 DAP. Ethofumesate PRE in a band application tended to provide less control than ethofumesate PRE as a broadcast application when followed by Roundup PowerMax plus ethofumesate as well as ethofumesate PRE in a band application when followed by Dual Magnum plus Roundup PowerMax and ethofumesate. However, early season control was generally good across all treatments.

Table 3. Sugarbeet injury and waterhemp control in response to PRE and EPOST herbicides, and POST treatment control of escaped waterhemp 8 and 17 DAT, Blomkest, MN, 2020.[a]

PRE / EPOST Herbicide Treatment[b]	Sgbt inj[b] 39 DAP[c]	Wahe[b] Control 47 DAP	POST Treatment[b]	Wahe Control 8 DAT[c]	Wahe Control 17 DAT
	----------%----------			----------%---------	
Etho (broadcast) / PM + etho / PM + etho	18	100 a	Roundup PowerMax + etho	99 a	99 a
Etho (band) / PM + etho / PM + etho/	11	89 b	Roundup PowerMax + etho	69 b	79 b
Etho (band) / Dual + PM + etho / Dual + PM + etho	5	96 ab	Liberty with Redball™ 915 hooded sprayer	93 a	91 a
Etho (band) / Dual + PM + etho / Dual + PM + etho	18	100 a	Inter-row cultivation	100 a	99 a
LSD (0.10)	**NS**	**8**		**10**	**11**

[a]Means within a column not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]etho = ethofumesate; PM = Roundup PowerMax; Dual = Dual Magnum; sgbt inj=sugarbeet injury; wahe = waterhemp.
[c]DAP = days after plant; DAT = days after treatment.

Greater than 90% control of up to 6-inch escaped waterhemp was observed from the POST application of Roundup PowerMax plus ethofumesate, Liberty with the hooded sprayer, or with inter-row cultivation when following ethofumesate applied PRE broadcast. Control from these POST treatments was significantly greater than Roundup PowerMax plus ethofumesate when following ethofumesate PRE applied in the band. These results support the idea of controlling escaped waterhemp using either the hooded sprayer or inter-row cultivation.

Sugarbeet injury was negligible in the Moorhead experiment in 2020 (data not presented). Waterhemp control at 28 DAP was greater than 80% (Table 4). Control of escaped waterhemp was greatest with inter-row cultivation. Waterhemp control was least with inter-row application of Liberty with the hooded sprayer or from ethofumesate PRE band-applied followed by three Roundup PowerMax plus ethofumesate applications. No differences were observed in sugarbeet root yield (data not presented), % sucrose, or recoverable sucrose per acre. However, recoverable sucrose per acre following waterhemp control with cultivation tended to be greater than recoverable sucrose from other treatments.

Table 4. Waterhemp control 28 DAP in response to PRE and EPOST treatments, and POST treatment control of escaped waterhemp 16 DAT and yield parameters in response to POST treatment, Moorhead, MN, 2020[a].

PRE / EPOST Herbicide Treatment[b]	Wahe[b] Control 28 DAP[c]	POST Treatment[b]	Wahe Control 16 DAT[c]	Sugarbeet Yield Sucrose	Sugarbeet Yield Rec. Suc.[b]
	---%---		-----------%-----------		---lb/A---
Etho (broadcast) / PM + etho / PM + etho	89 ab	Roundup PowerMax + etho	84 b	13.6	6,555
Etho (band) / PM + etho / PM + etho/	81 b	Roundup PowerMax + etho	76 bc	13.3	6,796
Etho (band) / Dual + PM + etho / Dual + PM + etho	91 a	Liberty with Redball™ 915 hooded sprayer	68 c	13.5	6,425
Etho (band) / Dual + PM + etho / Dual + PM + etho	95 a	Inter-row cultivation	99 a	13.7	6,952
LSD (0.10)	**8**		**13**	**NS**	**NS**

[a]Means within column not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]etho = ethofumesate; PM = Roundup PowerMax; Dual = Dual Magnum; wahe = waterhemp, Rec. Suc. = recoverable sucrose.
[c]DAP = days after plant; DAT = days after treatment.

Inter-row cultivation controlled 2- to 4-inch escaped waterhemp at Blomkest (Table 3) and Moorhead (Table 4) in 2020. Inter-row application of Liberty with the hooded sprayer controlled escaped waterhemp at Blomkest but not at

Moorhead. Inconsistent results with the hooded sprayer may have been related to an equipment malfunction at Moorhead rather than the herbicide treatment.

Planned program treatments applied PRE, EPOST, and POST caused negligible sugarbeet injury and provided similar waterhemp control 40 DAP at Blomkest in 2021 (Table 5). Waterhemp control ranged from 75% to 94% with ethofumesate PRE broadcast followed by Roundup PowerMax plus ethofumesate applied at the 4- and 8-lf stages giving the greatest waterhemp control.

Table 5. Waterhemp control 40 DAP in response to PRE and EPOST treatments and POST treatments control of escape waterhemp 2 and 24 DAT, Blomkest, MN, 2021.[a]

PRE / EPOST	Sgbt Inj.[b]	Wahe[b] Control	POST	Sgbt Inj.	Wahe Control	
Herbicide Treatment[b]	40 DAP[c]	40 DAP	Treatment[b]	16 DAT[c]	2 DAT	24 DAT
	---------%--------			--------------%-------------		
Etho (broadcast) / PM + etho / PM + etho	0	94	Roundup PowerMax + etho	0 b	79 bc	78 bc
Etho (band) / PM+etho / PM+etho/	0	79	Roundup PowerMax + etho	0 b	73 c	70 c
Etho (band) / Dual+PM+etho / Dual+PM+etho	4	75	Liberty with Redball™ 915 hooded sprayer	3 b	75 c	86 ab
Etho (band) /Dual+PM+etho / Dual+PM+etho	4	79	Gramoxone with Redball™ 915 hooded sprayer	3 b	90 ab	87 ab
Etho (band) / Dual+PM+etho / Dual+PM+etho	4	78	Inter-row cultivation	0 b	96 a	93 a
Etho (band) / Dual+PM+etho / Dual+PM+etho	0	85	Ultra Blazer+PM+ NIS+ AMS	18 a	81 bc	90 ab
LSD (0.10)	**NS**	**NS**		**9**	**14**	**13**

[a]Means within a column not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]etho = ethofumesate; PM = Roundup PowerMax; Dual = Dual Magnum; sgbt Inj. = sugarbeet injury; wahe = waterhemp.
[c]DAP = days after plant; DAT = days after treatment.

Inter-row application of Gramoxone with the Redball 915 hooded sprayer or inter-row cultivation provided immediate control of 90% and 96%, respectively, 3- to 12-inch escaped waterhemp at 2 DAT. Waterhemp control from Gramoxone via the hooded sprayer was similar to Ultra Blazer plus Roundup PowerMax and similar to Roundup PowerMax plus ethofumesate when following ethofumesate broadcast PRE. Escaped waterhemp control from Gramoxone with the hooded sprayer, inter-row cultivation, Ultra Blazer plus Roundup PowerMax, and Liberty with the hooded sprayer was or tended to be greater than waterhemp control from Roundup PowerMax plus ethofumesate at 24 DAT.

Conclusions

Waterhemp control challenges in sugarbeet is forcing agriculturalists to reconsider weed management strategies and evaluate 10- to 12-lf sugarbeet growth stage treatments. Escaped waterhemp did not reduce yield (Moorhead, 2020) but produced seed that developed into a production challenge for crops grown in sequence with sugarbeet. This research found there are multiple useful tools to control escaped waterhemp including inter-row cultivation, the hooded sprayer, and Ultra Blazer.

A secondary outcome of these experiments was applying ethofumesate PRE in an 11-inch band. This application method could be utilized to save money while maintaining waterhemp control, especially if the producer is using layered residuals or herbicides applied at the 2- to 4- and 6- to 8-lf stage in sugarbeet. Also, observations suggest that the first in-season chloroacetamide application should be timed to 2- to 4-lf stage sugarbeet, even if ethofumesate PRE is applied.

SUGARBEET TOLERANCE AND WATERHEMP CONTROL FROM ULTRA BLAZER IN A WEED MANAGEMENT PROGRAM

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Summary
1. Ultra Blazer (acifluorfen) must be applied alone or with glyphosate postemergence (POST) at the 6 leaf sugarbeet stage or greater.
2. Preemergence (PRE) applications did not affect sugarbeet injury, root yield, % sucrose, or recoverable sucrose from Roundup PowerMax, ethofumesate, Ultra Blazer and/or Dual Magnum.
3. Ultra Blazer in a waterhemp management program caused significant sugarbeet injury and reduced root yield and recoverable sucrose compared with Roundup PowerMax and Dual Magnum and/or ethofumesate.
4. Ultra Blazer is best used as a tool to control escaped waterhemp; NOT as part of a weed control program.
5. Waterhemp control results support Ultra Blazer application to control waterhemp escapes.

Introduction
Sugarbeet tolerance and waterhemp control from POST Ultra Blazer applications were investigated in 2019 and 2020. Two conclusions of this research were realized. First, Ultra Blazer applied at 16 fl oz/A should be timed to 6 leaf or greater sugarbeet. Ultra Blazer applied before the 6 leaf sugarbeet stage causes necrosis and stature reduction that reduces root yield and recoverable sucrose. Second, sugarbeet tolerance or waterhemp control from Ultra Blazer is influenced by adjuvant type and herbicide mixture with Ultra Blazer. We observed greater waterhemp control from Ultra Blazer mixtures with Roundup PowerMax, Stinger, and/or ethofumesate than from these herbicides applied individually. Previous research indicates Ultra Blazer postemergence provides effective control of other broadleaf weeds including kochia, redroot pigweed, palmer amaranth, and Pennsylvania smartweed.

Ultra Blazer may fit best in a weed management program with glyphosate, ethofumesate, and a chloroacetamide herbicide timed at the 6-lf sugarbeet stage or mixed with glyphosate and timed to the 8- to 12-lf stage. 2021 experiments were directed to explore both tolerance and weed control from Ultra Blazer as either a component in a weed management program or a treatment to control escape waterhemp.

Objectives
2021 objectives are a) determine if sugarbeet tolerate Ultra Blazer when applied in a waterhemp control program with Roundup PowerMax, ethofumesate, and Dual Magnum at the 6-lf sugarbeet stage; and b) evaluate sugarbeet tolerance and waterhemp control from Ultra Blazer mixtures with Roundup PowerMax, ethofumesate, Dual Magnum, and/or Stinger at the 6- to 8-lf sugarbeet stage.

Materials and Methods
Sugarbeet Tolerance
Experiments conducted in 2021 near Crookston, Hendrum, Norcross, and Murdock, MN evaluated sugarbeet tolerance from Ultra Blazer as a component in the waterhemp management program. 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.

Visible sugarbeet necrosis, malformation, and growth reduction were evaluated 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 sugarbeet 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 in a factorial treatment arrangement with factors being preemergence and postemergence herbicide. Data were analyzed in this report as a RCBD with the ANOVA procedure of ARM, version 2021.2 software package.

Table 1. Herbicide treatment, rate, and application timing, sugarbeet tolerance.

Factor A PRE Herbicide	Factor B Postemergence Herbicide	Rate (fl oz/A)	Sugarbeet stage (lf)
No	Roundup PowerMax[a] + etho[b] / Roundup PowerMax + etho	28 + 6 / 28 + 6	2 / 6-8
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	28 + 6 + 16 / 28 + 6 + 16	2 / 6-8
No	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer[c]	28 + 6 / 28 + 16	2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax[a] + etho / Roundup PowerMax + etho	8 + 32 / 28 + 6 / 28 + 6	PRE / 2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	8 + 32 / 2 + 6 + 16 / 28 + 6 + 16	PRE / 2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer	8 + 32 / 28 + 6 / 28 + 16	PRE / 2 / 6-8

[a]Roundup PowerMax + ethofumesate applied with Destiny HC HSMOC at 1.5 pt/A and Amsol Liquid AMS at 2.5 % v/v.
[b]etho = ethofumesate.
[c]Ultra Blazer applied with Prefer 90 non-ionic surfactant at 0.125% v/v.

Ultra Blazer Efficacy

Efficacy experiments were conducted on natural populations of waterhemp in sugarbeet grower fields near Moorhead, Glyndon, and Blomkest, MN in 2021. We elected not to include the Moorhead site in this summary due to poor early season sugarbeet development. All treatments (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.

Visible sugarbeet necrosis, malformation, and growth reduction were evaluated as sugarbeet injury using a 0 to 100% injury scale with 0% denoting no sugarbeet injury and 100% denoting complete loss of sugarbeet stature. Weed control was also evaluated as percent biomass reduction. All evaluations were a visual estimate of injury or control in the four treated rows compared to the adjacent, two-row, untreated strip. Experimental design was a randomized complete block design with four replications in a factorial treatment arrangement with factors being preemergence and postemergence herbicides. Data were analyzed in this report as a RCBD with the ANOVA procedure of ARM, version 2021.2 software package.

Table 2. Herbicide treatment, rate, and application timing, sugarbeet efficacy.

Factor A PRE Herbicide	Factor B POST Herbicide	Rate (fl oz /A)	Sugarbeet stage (lf)
No	Roundup PowerMax[a] + etho[b] / Roundup PowerMax + etho	28 + 6 / 28 + 6	2 / 6-8
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	28 + 6 + 16 / 28 + 6 + 16	2 / 6-8
No	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer[c]	28 + 6 / 28 + 16	2 / 6-8
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Dual Magnum + Ultra Blazer	28 + 6 + 16 / 28 + 16 + 16	2 / 6-8
No	Roundup PowerMax + etho + Dual Magnum + Stinger / Roundup PowerMax + Dual Magnum + Ultra Blazer + Stinger	28 + 6 + 16 + 3 / 28 + 16 + 16 + 3	2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + etho	8 + 32 / 28 +6 / 28 + 6	PRE / 2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	38 + 32 / 28 + 6 + 16 / 28 + 6 + 16	PRE / 2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer	8 + 32 / 28 + 6 / 28 + 16	PRE / 2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Dual Magnum + Ultra Blazer	8 + 32 / 28 + 6 + 16 / 28 + 16 + 16	PRE / 2 / 6-8
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum + Stinger / Roundup PowerMax + Dual Magnum + Ultra Blazer + Stinger	8 + 32 / 28 + 6 + 16 + 3 / 28 + 16 + 16 + 3	PRE / 2 / 6-8

[a]Roundup PowerMax + ethofumesate applied with Destiny HC HSMOC at 1.5 pt/A and Amsol Liquid AMS at 2.5 % v/v.
[b]etho = ethofumesate.
[c]Ultra Blazer applied with Prefer 90 non-ionic surfactant at 0.125% v/v.

Results

Sugarbeet Tolerance

Sugarbeet injury, root yield, % sucrose, and recoverable sucrose from herbicide treatments applied POST were not affected by PRE treatment (Tables 3 and 4). Sugarbeet injury occurred 7 and 14 days after treatment (DAT) from Roundup PowerMax plus ethofumesate and Dual Magnum as well as Roundup PowerMax plus Ultra Blazer and Dual Magnum compared with Roundup PowerMax plus ethofumesate alone; however, sugarbeet injury from Roundup PowerMax plus ethofumesate and Dual Magnum was the same as Roundup PowerMax plus ethofumesate alone by 21 DAT. Sugarbeet injury at 7, 14, and 21 DAT was always greater when Ultra Blazer was mixed with Roundup PowerMax and Dual Magnum.

Treatments containing Ultra Blazer reduced root yield and recoverable sucrose as compared with Roundup PowerMax plus ethofumesate or Roundup PowerMax plus ethofumesate and Dual Magnum (Table 4). However, sucrose content was not affected by Ultra Blazer. These results indicate that Ultra Blazer applied as part of a weed management program reduces sugarbeet stature, root yield, and recoverable sucrose.

Table 3. Sugarbeet injury of necrosis and growth reduction in response to herbicide treatment, averaged across four locations, 2021.[a]

PRE Herbicide	POST Herbicide	Rate	Sugarbeet Injury 7 DAT[b]	14 DAT	21 DAT
		----fl oz /A----	---------------%----------------		
No	Roundup PowerMax + etho[c] / Roundup PowerMax + etho	28 + 6 / 28 + 6	3 a	2 a	3 a
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	16 + 6 + 28 / 16 + 6 + 28	11 bc	9 b	6 a
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Ultra Blazer + Dual Magnum	28 + 6 + 16 / 28 + 6 + 16	44 d	42 c	32 b
Etho+Dual Magnum	Roundup PowerMax + etho / Roundup PowerMax + etho	32 + 8 / 28 + 6 / 28 + 6	4 ab	1 a	2 a
Etho+Dual Magnum	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	32 + 8 / 28 + 6 + 16 / 28 + 6 + 16	13 c	8 b	7 a
Etho+Dual Magnum	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Ultra Blazer + Dual Magnum	32 + 8 / 28 + 6 + 16 / 28 + 16 + 16	50 d	43 c	35 b
P-Value			**<0.0001**	**<0.0001**	**<0.0001**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.
[b]DAT = days after treatment.
[c]etho = ethofumesate.

Table 4. Sugarbeet root yield, % sucrose, and recoverable sucrose in response to herbicide treatment across four locations, 2021.[a]

PRE Herbicide	POST Herbicide	Rate	Root Yield	Sucrose	Recoverable Sucrose
		----fl oz/A----	-Ton/A-	--%--	---lb/A---
No	Roundup PowerMax + etho[c] / Roundup PowerMax + etho	28 + 6 / 28 + 6	38 a	15.9	10, 423 a
No	Roundup PowerMax + etho + Dual Magnum[d] / Roundup PowerMax + etho + Dual Magnum	16 + 6 + 28 / 16 + 6 + 28	36 a	15.8	10, 040 a
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Ultra Blazer + Dual Magnum	28 + 6 + 16 / 28 + 6 + 16	32 b	15.5	8,713 b
Etho+Dual Magnum	Roundup PowerMax + etho / Roundup PowerMax + etho	32 + 8 / 28 + 6 / 28 + 6	38 a	15.7	10, 223 a
Etho+Dual Magnum	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	32 + 8 / 28 + 6 + 16 / 28 + 6 + 16	37 a	15.7	10, 141 a
Etho+Dual Magnum	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Ultra Blazer + Dual Magnum	32 + 8 / 28 + 6 + 16 / 28 + 16 + 16	32 b	15.6	8, 507 b
P-Value			**<0.0001**	**0.2402**	**<0.0001**

[a]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.
[b]DAT = days after treatment.
[c]etho = ethofumesate.

Ultra Blazer Efficacy

The experiment at Moorhead, MN had poor stands and sporadic weeds, especially early in the growing season. Due to variability, discussion will focus on results from Blomkest and Glyndon experiments.

Sugarbeet injury at Glyndon was greater than Blomkest (Table 5). Daily maximum air temperature was 75°F and 82°F on May 31 and June 1, respectively, but increased to greater than 90°F on June 3, the date of the POST application at Glyndon. Daily maximum air temperatures averaged above 90°F through June 10 at Glyndon, MN which likely contributed to sugarbeet injury. Sugarbeet injury was not limited to only treatments containing Ultra Blazer. Multiple applications of Roundup PowerMax plus ethofumesate and Dual Magnum at the 2- and 6-lf stage caused more injury than Roundup PowerMax plus ethofumesate at the 2-lf stage followed by Roundup PowerMax plus ethofumesate at the 6-lf stage.

Table 5. Sugarbeet injury from tank mixtures with Ultra Blazer, 14 DAT, Glyndon and Blomkest, MN, 2021.[a]

			Sugarbeet Injury	
PRE Herbicide	**POST Herbicide[b]**	**Rate**	**Glyndon**	**Blomkest**
		--fl oz/A--	--------%--------	
No	Roundup PowerMax + etho[c] / Roundup PowerMax + etho	28 + 6 / 28 + 6	0 d	4 c
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	28 + 6 + 16 / 28 + 6 + 16	15 cd	8 c
No	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer[d]	28 + 6 / 28 + 16	72 ab	33 b
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Dual Magnum + Ultra Blazer	28 + 6 + 16 / 28 + 16 + 16	84 a	43 ab
No	Roundup PowerMax + etho + Dual Magnum + Stinger / Roundup PowerMax + Dual Magnum + Ultra Blazer + Stinger	28 + 6 + 16 + 3 / 28 + 16 + 16 + 3	86 a	45 ab
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + etho	8 + 32 / 28 + 6 / 28 + 6	12 d	0 c
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	8 + 32 / 28 + 6 + 16 / 28 + 6 + 16	29 c	6 c
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer	8 + 32 / 28 + 6 / 28 + 16	64 b	35 b
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Dual Magnum + Ultra Blazer	8 + 32 / 28 + 6 + 16 / 28 + 16 + 16	86 a	41 ab
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum + Stinger / Roundup PowerMax + Dual Magnum + Ultra Blazer + Stinger	8 + 32 / 28 + 6 + 16 + 3 / 28 + 16 + 16 + 3	86 a	49 a
LSD (0.10)			**16**	**13**

[a]Means within location not sharing any letters are significantly different by the LSD at the 10% level of significance.
[b]Roundup PowerMax + ethofumesate applied with Destiny HC HSMOC at 1.5 pt/A and Amsol Liquid AMS at 2.5 % v/v.
[c]etho = ethofumesate.
[d]Ultra Blazer treatments applied with Prefer 90 non-ionic surfactant at 0.25% v/v.

Sugarbeet injury from treatments containing Ultra Blazer were greater than treatments containing Roundup PowerMax, ethofumesate, and/or Dual Magnum at Blomkest. However, injury was similar among treatments containing Roundup PowerMax, ethofumesate, and Dual Magnum. The addition of Stinger to Roundup PowerMax plus Ultra Blazer and Dual Magnum did not increase sugarbeet injury as compared with Roundup PowerMax plus Ultra Blazer and Dual Magnum alone. PRE herbicide did not affect sugarbeet injury.

Ultra Blazer improved waterhemp control compared with Roundup PowerMax plus ethofumesate alone or Roundup PowerMax mixtures with ethofumesate and Dual Magnum at Blomkest, but only improved waterhemp control compared with Roundup PowerMax plus ethofumesate in the absence of a PRE at Glyndon (Table 6). Blomkest was much drier than Glyndon, especially in April and May. Similar waterhemp control was observed from Ultra Blazer mixtures with Roundup PowerMax or Ultra Blazer mixtures with Roundup PowerMax and Dual Magnum at both locations. Waterhemp control was numerically greatest when Ultra Blazer was mixed with Roundup PowerMax, Dual Magnum, and Stinger. However, this treatment also caused the most sugarbeet injury at Blomkest (Table 5). Waterhemp control results support Ultra Blazer applied POST to control waterhemp escapes.

Glyphosate provided excellent common lambsquarters control at Glyndon and Blomkest (data not presented).

Table 6. Waterhemp control from tank mixtures with Ultra Blazer, 14 DAT, Blomkest and Glyndon, MN, 2021.[a]

			Waterhemp Control	
PRE Herbicide	**Postemergence Herbicide[b]**	**Rate**	**Glyndon**	**Blomkest**
		--fl oz/A--	---------%---------	
No	Roundup PowerMax + etho[c] / Roundup PowerMax + etho	28 + 6 / 28 + 6	85 b	65 e
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	28 + 6 + 16 / 28 + 6 + 16	94 ab	69 de
No	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer[d]	28 + 6 / 28 + 16	90 ab	90 ab
No	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Dual Magnum + Ultra Blazer	28 + 6 + 16 / 28 + 16 + 16	98 a	94 a
No	Roundup PowerMax + etho + Dual Magnum + Stinger / Roundup PowerMax + Dual Magnum + Ultra Blazer + Stinger	28 + 6 + 16 + 3 / 28 + 16 + 16 + 3	99 a	93 ab
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + etho	8 + 32 / 28 + 6 / 28 + 6	93 ab	83 bc
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + etho + Dual Magnum	8 + 32 / 28 + 6 + 16 / 28 + 6 + 16	99 a	78 cd
Dual Magnum + ethofumesate	Roundup PowerMax + etho / Roundup PowerMax + Ultra Blazer	8 + 32 / 28 + 6 / 28 + 16	96 ab	94 ab
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum / Roundup PowerMax + Dual Magnum + Ultra Blazer	8 + 32 / 28 + 6 + 16 / 28 + 16 + 16	98 a	95 a
Dual Magnum + ethofumesate	Roundup PowerMax + etho + Dual Magnum + Stinger / Roundup PowerMax + Dual Magnum + Ultra Blazer + Stinger	8 + 32 / 28 + 6 + 16 + 3 / 28 + 16 + 16 + 3	99 a	98 a
LSD (0.10)			**12**	**11**

[a]Means within a location not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]Roundup PowerMax + ethofumesate applied with Destiny HC HSMOC at 1.5 pt/A and Amsol Liquid AMS at 2.5 % v/v.
[c]etho = ethofumesate.
[d]Ultra Blazer treatments applied with Prefer 90 non-ionic surfactant at 0.25% v/v.

Conclusion

Ultra Blazer applied with Roundup PowerMax and Dual Magnum increased visual sugarbeet injury and reduced root yield and recoverable sucrose as compared with Roundup PowerMax plus ethofumesate alone or in mixtures with Dual Magnum. Thus, we strongly discourage UPL or agriculturalists from recommending the tank mix of Ultra Blazer with Roundup PowerMax and Dual Magnum. Dual Magnum was the only chloroacetamide used in this experiment and it is possible the results may not translate to mixtures with Outlook or Warrant. However, our research indicates sugarbeet injury increases when oil-based formulations are mixed with Ultra Blazer.

These experiments support Ultra Blazer application to control waterhemp escapes. Ultra Blazer has been shown most effective on waterhemp less than 2-inches tall. Ultra Blazer improved waterhemp control compared with Roundup PowerMax plus ethofumesate alone and improved control from Roundup PowerMax mixtures with ethofumesate and Dual Magnum in an environment where rainfall to incorporate soil residual herbicides was lacking. Waterhemp control numerically was greatest when Ultra Blazer was mixed with Roundup PowerMax, Dual

Magnum, and Stinger. However, this treatment caused the most sugarbeet injury at Blomkest. Waterhemp control results support Ultra Blazer application to control waterhemp escapes.

ULTRA BLAZER SECTION 18 EMERGENCY EXEMPTION AND SUPPORTING EXPERIMENTS

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Summary

1. Ninety-five percent of respondents indicated the emergency exemption was beneficial for sugarbeet producers in Minnesota and North Dakota and contributed to overall weed management in 2021.
2. Ninety-two percent of respondents indicated they would willingly support application for a 2022 emergency exemption in sugarbeet.
3. Control from Ultra Blazer decreases as waterhemp size increases from 1-inch to greater than 6-inches.
4. Spray volume (gpa), ground speed (mph), and waterhemp size influenced control and regrowth. Further research and training is needed to optimize waterhemp control.

Introduction

The Environmental Protection Agency (EPA) approved a 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 2021. 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. The report contains three 2021 program objectives: a) summarize results and user experiences from the 2021 Section 18 emergency exemption for use of Ultra Blazer in sugarbeet; b) summarize an experiment developed to provide producers and agriculturalists with scientific insight as to what Ultra Blazer delivers in sugarbeet production; c) determine reduction in control from Ultra Blazer as waterhemp height increases from 2- to 6-inches.

Materials and Methods

Section 18 Emergency Exemption

Ultra Blazer was applied at 16 fl oz/A alone or with glyphosate and non-ionic surfactant (NIS) plus ammonium sulfate (AMS). One Ultra Blazer application was made per season using ground application equipment and targeted 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 June 2 through July 31, 2021.

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

Demonstrations plots were established near Casselton, ND and near Crookston, Hendrum, Foxhome and Benson, MN to train producers and agriculturalists on the plant response from Ultra Blazer alone, with glyphosate, and/or with adjuvants (Table 1).

Table 1. Herbicide treatment, rate, and application timing to Ultra Blazer demonstration plots in sugarbeet fields, 2021.

Num	Treatment	Rate (fl oz/A)	Sugarbeet Stage (lvs)
1	Ultra Blazer	16	>6
2	Ultra Blazer + Prefer 90 NIS	16 + 0.125% v/v	>6
3	Ultra Blazer + Prefer 90 NIS	16 + 0.25% v/v	>6
4	Ultra Blazer + Roundup PowerMax + Amsol Liquid AMS	16 + 28 + 2.5 % v/v	>6
5	Ultra Blazer + Roundup PowerMax + Prefer 90 NIS + Amsol Liquid AMS	16 + 28 + 0.25% v/v + 2.5 % v/v	>6

Visible sugarbeet necrosis, malformation, and growth reduction were observed as injury symptoms and evaluated 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. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2021.2 software package.

Waterhemp Control as Influenced by Height

PRE, EPOST, and POST treatments (Table 2) created waterhemp size and density differences in plots. Late postemergence (LPOST) treatments were applied to evaluate control of waterhemp escapes. Treatments were applied to the center four rows of six row plots 40 feet in length using a bicycle sprayer. Herbicides were applied in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi. Visible sugarbeet necrosis, malformation, and growth reduction were observed as injury symptoms and evaluated 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. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2021.2 software package.

Table 2. Herbicide treatment, rate, and application timing in waterhemp control trials, 2021.

Herbicide Treatment	Rate (fl oz/A)	Application timing (SGBT leaf stage)
Ethofumesate (broadcast) / Roundup PowerMax + ethofumesate[1] / Roundup PowerMax + ethofumesate / Roundup PowerMax + ethofumesate	96 / 28 + 4 / 28 + 4 / 22 + 4	PRE / 4 lf / 6 lf / 8-10 lf
Ethofumesate[2] / Roundup PowerMax + ethofumesate[1] / Roundup PowerMax + ethofumesate / Roundup PowerMax + ethofumesate	48 / 28 + 4 / 28 + 4 / 22 + 4	PRE / 4 lf / 6 lf / 8-10 lf
Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax[3]	16 + 32 + 12 / 16 + 22	4 lf / 8-10 lf
Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax	16 + 32 + 12 / 16 + 22	6 lf / 8-10 lf
Dual Magnum + Roundup PowerMax + ethofumesate / Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax	16 + 28 + 6 / 16 + 28 + 6 / 16 + 22	4 lf / 6 lf / 8-10 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax	48 / 16 + 32 + 12 / 16 + 22	PRE / 4 lf / 8-10 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax	48 / 16 + 32 + 12 / 16 + 22	PRE / 6 lf / 8-10 lf
Ethofumesate[2] / Dual Magnum + Roundup PowerMax + ethofumesate / Dual Magnum + Roundup PowerMax + ethofumesate / Ultra Blazer + Roundup PowerMax	48 / 16 + 32 + 12 / 16 + 32 + 12 / 16 + 22	PRE / 4 lf / 6 lf / 8-10 lf

[1]Roundup PowerMax + ethofumesate applied with Destiny HC @ 1.5 pt/A + Amsol AMS at 2.5% v/v.
[2]Ethofumesate applied using a banded application.
[3]Roundup PowerMax + Ultra Blazer applied with Prefer 90 NIS @ 0.25% v/v and NPak AMS at 2.5% v/v.

Results

According to a survey of sugarbeet growers and agriculturalists, Ultra Blazer at 16 fl oz/A was applied to 32,005 sugarbeet acres in 2021 (totaling 4,001 gallons of Ultra Blazer). Ninety percent or 28,711 acres were applied in Minnesota and 10% or 3,294 acres were applied in North Dakota.

The air temperature at application and variability in sugarbeet growth stage complicated Ultra Blazer application, especially applications made in early June, 2021. The maximum daily air temperature in much of the sugarbeet growing area (represented by Hillsboro, ND and Blomkest, MN) was 80 to 102°F from June 2 through at least June 15, 2021 (Figure 1). In the five years (2016 to 2020) leading up to the Section 18 application for Ultra Blazer, air temperature at application had not been greater than 85°F in any of our research trials.

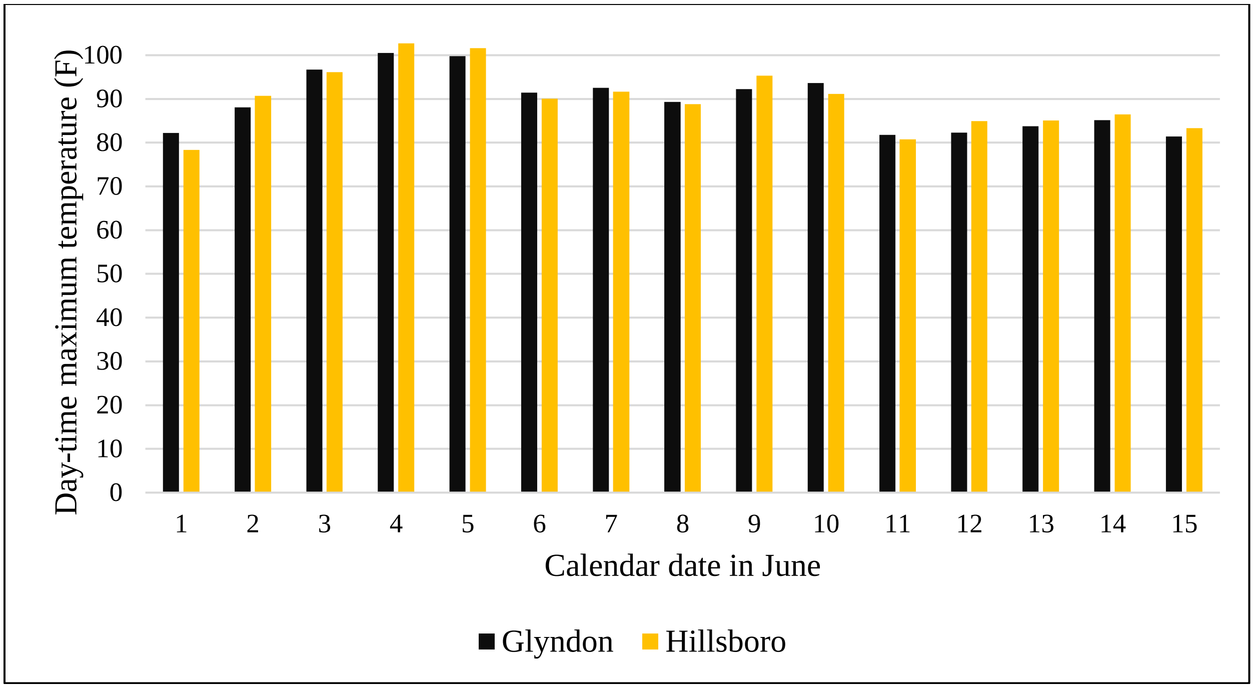


Figure 1. Day time maximum air temperature, June 1 to June 15, Hillsboro, ND and Blomkest, MN, 2021.

The variability of sugarbeet growth stage at application further complicated Ultra Blazer application. Our recommendation was for application to sugarbeet greater than the 6-lf stage. However, dry planting conditions in April and May caused variable emergence and sugarbeet stands ranged from cotyledon to 8-lf at application.

Sugarbeet producers and agriculturalists were asked in a survey to evaluate sugarbeet injury and waterhemp control from Ultra Blazer. When compiling sugarbeet injury responses, no injury = 1, slight = 2, moderate = 3, and severe injury = 4. When compiling waterhemp control responses, excellent =1, good = 2, fair = 3, and poor control = 4. When averaged across all responses, sugarbeet injury was reported as slight to moderate (2.6) and waterhemp control as good to fair (Figure 2). Only one respondent categorized sugarbeet injury as severe. Respondents from the northern Red River Valley (RRV) graded injury greater (2.8) than respondents from the southern RRV (2.4) or respondents from west central Minnesota (2.6) suggesting their lack of familiarity with or tolerance for sugarbeet injury. Waterhemp control was rated good to fair with negligible differences in responses across the growing regions. Although no unintended effects such as increased susceptibility to disease or reduced % sucrose content were reported by producers or agriculturalists, there were inconsistent results in regard to sugarbeet tolerance and waterhemp control. This indicates a need for application method refinements if Ultra Blazer is used on sugarbeet in the future. Agriculturalists and producers were asked if they found the Section 18 Emergency Exemption useful and if they supported applying for a 2022 Emergency Exemption. Ninety-five percent of the respondents found the Section 18 Emergency Exemption beneficial for sugarbeet growers and 92% supported reapplication for the Emergency Exemption in 2022.

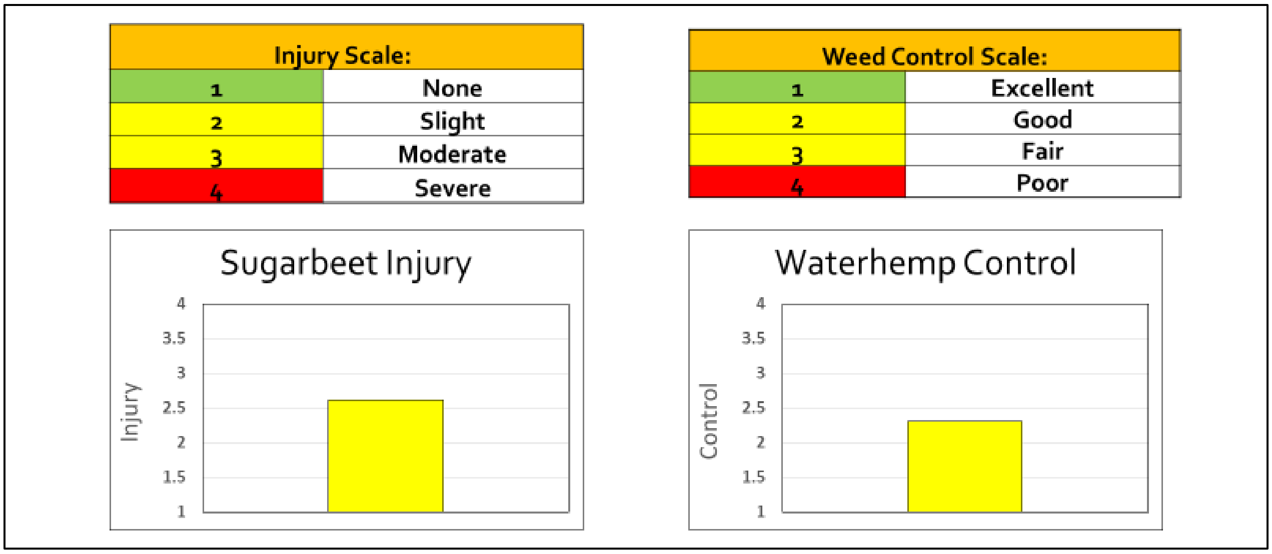


Figure 2. Results of producer and agriculturalist survey of sugarbeet injury and waterhemp control from Ultra Blazer Section 18 Emergency Exemption, Minnesota and North Dakota, 2021.

Ultra Blazer is a contact herbicide PPO inhibitor that is applied POST and is light activated. When activated, this product forms highly reactive compounds in the plants that rupture cell membranes causing fluids to leak. Injury symptoms can occur as soon as 1 to 2 hours after application. Environmental conditions will affect Ultra Blazer injury to sugarbeet. Symptoms are most apparent with bright, sunny conditions and increased humidity at application.

Efficacy is best when Ultra Blazer is used at high water volumes (15 to 25 gpa water volume) with flat fan nozzles producing a fine droplet spectrum to 'paint the plant' ensuring good coverage. Oil-based adjuvants with Ultra Blazer increase waterhemp control and sugarbeet injury as compared with non-ionic surfactants. Likewise, herbicide mixtures, including glyphosate, will potentially increase sugarbeet injury.

Sugarbeet Tolerance
Sugarbeet visual percent injury was evaluated 3 to 16 days after treatment (DAT) across locations. Sugarbeet injury ranged from 8% to 40% depending on herbicide treatment and location (Table 3). Sugarbeet injury tended to be less with Ultra Blazer alone and increased with addition of adjuvant and/or adjuvant rate. Sugarbeet injury increased when Roundup PowerMax was mixed with Ultra Blazer as compared with Ultra Blazer alone or with adjuvants. Sugarbeet injury was greatest at Benson, MN. The air temperature at Benson at 11:00AM was 95°F. Air temperature was 88°F, 79°F, 88°F, and 86°F at application at Casselton, Crookston, Foxhome, and Hendrum, respectively. Root yield, % sucrose, and recoverable sucrose was collected at Hendrum, MN. Yield parameters were collected by hand from a 37 square foot area. This is approximately 1/3 of our normal mechanically harvested area. Data was variable but suggested reduced yield when adjuvant or Roundup PowerMax was mixed with Ultra Blazer compared with applying Ultra Blazer alone. Percent sucrose was the same across treatments.

Table 3. Visual percent sugarbeet injury in response to herbicide treatment, 3 to 16 DAT at multiple locations, 2021[a].

Herbicide Treatment	Adj. Rate[b]	Casselton	Crookston	Foxhome	Hendrum	Benson
	--pt/100 gal--	--------------------------------%-----------------------------				
Ultra Blazer[c]	-	9 d	9 c	10 c	8 d	-
Ultra Blazer + Prefer 90 NIS	1	14 c	10 bc	11 bc	10 cd	-
Ultra Blazer + Prefer 90 NIS	2	15 bc	15 ab	18 b	15 c	-
Ultra Blazer + Prefer 90 NIS + Amsol liquid AMS	2 + 20	-	-	-	-	35
RUPM[d] + Ultra Blazer + Amsol liquid AMS	20	19 b	20 a	25 a	21 b	-
RUPM[d] + Ultra Blazer + Prefer 90 NIS + Amsol liquid AMS	2 + 20	28 a	-	26 a	30 a	40
LSD (0.10)		**4**	**5**	**6**	**6**	**NS**

[a]Means within a location not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]Adj. Rate = Adjuvant Rate.
[c]Ultra Blazer applied at 16 fl oz/A in all treatments.
[d] RUPM = Roundup PowerMax applied at 28 fl oz/A in respective treatments.

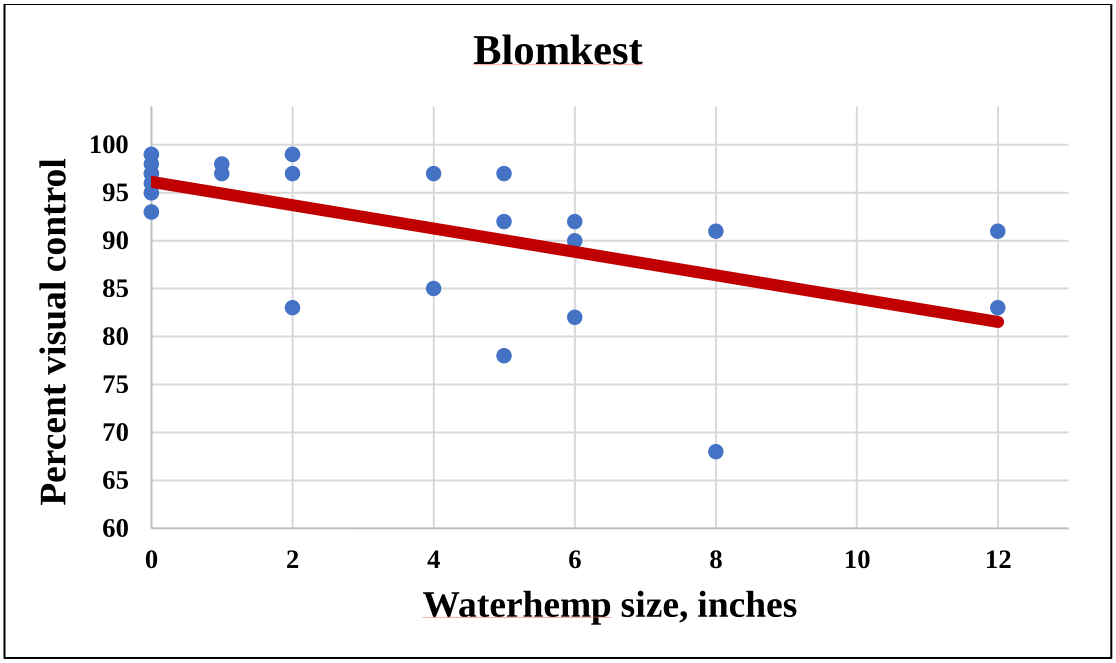
Table 4. Visual percent sugarbeet injury and sugarbeet yield parameters in response to herbicide treatment, Hendrum, MN, 2021[a].

Herbicide Treatment	Adj. Rate[b]	Sgbt inj[c]	Sgbt inj	Yield	Sucrose	Rec Suc[d]
	--pt/100 gal--	---------%---------		-Ton/A-	--%--	--lb/A--
Ultra Blazer[e]	-	8 d	0 b	27.1 a	17.8	9,002 a
Ultra Blazer + Prefer 90 NIS	1	10 cd	0 b	24.7 b	17.6	8,091 ab
Ultra Blazer + Prefer 90 NIS	2	15 c	3 b	24.4 b	17.9	8,163 ab
RUPM[f] + Ultra Blazer + Amsol liquid AMS	20	21 b	10 a	24.1 b	17.6	7,864 b
RUPM[f] + Ultra Blazer + Prefer 90 NIS + Amsol liquid AMS	2 + 20	30 a	10 a	25.2 ab	18.1	8,514 ab
LSD (0.10)		**6**	**4**	**2.4**	**NS**	**944**

[a]Means within a main effect not sharing any letter are significantly different by the LSD at the 10% level of significance.
[b]Adj. Rate = Adjuvant Rate.
[c]Sgbt inj. = Sugarbeet Injury.
[d]Rec. Suc. = Recoverable Sucrose.
[e]Ultra Blazer applied at 16 fl oz/A in all treatments.
[f]RUPM = Roundup PowerMax applied at 28 fl oz/A in respective treatments.

Waterhemp Control as Influenced by Height

Waterhemp control decreased as waterhemp size increased at Blomkest and Moorhead (Figure 3). The negative slope of the line was greater at Moorhead than Blomkest indicating waterhemp control decreased more rapidly at Moorhead than at Blomkest in response to waterhemp height. Air temperature was 75°F at application at Moorhead and Blomkest. Sugarbeet size and growth stage was greater at Moorhead, which may have reduced herbicide coverage on waterhemp as compared with the Blomkest location.



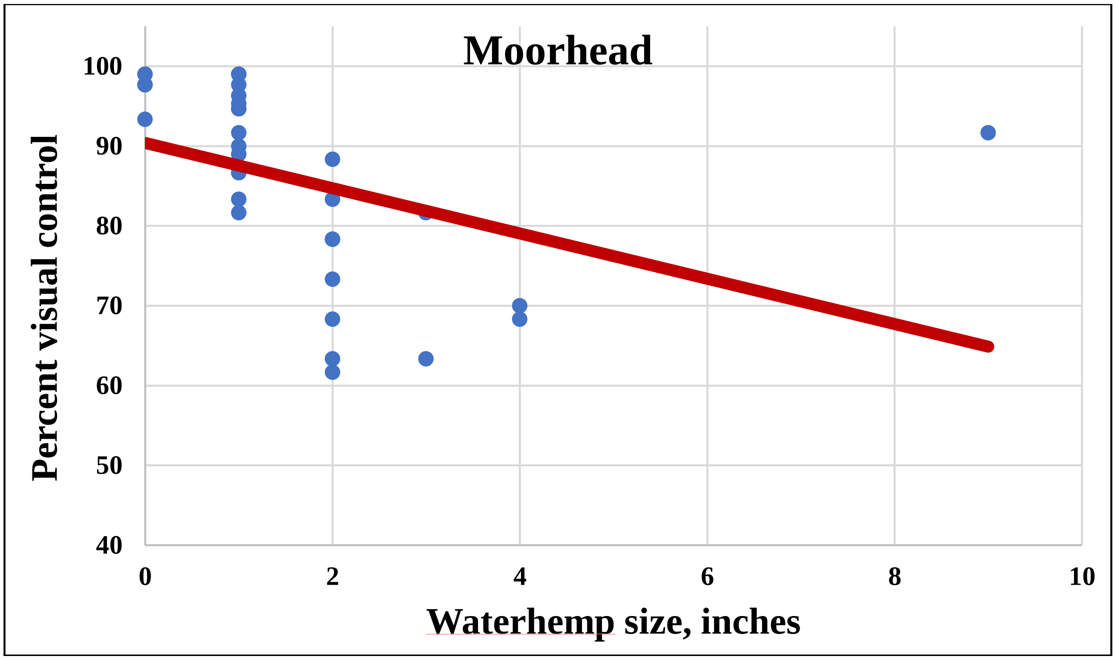


Figure 3. Visual percent waterhemp control in response to waterhemp size, Blomkest and Moorhead, MN, 2021.

Conclusion

Using Ultra Blazer will be a compromise between sugarbeet injury and weed control. Methods to improve control such as adjuvant selection and rate or herbicides tank-mixed with Ultra Blazer, as well as environmental conditions at application, must be considered as different combinations will increase sugarbeet injury. Application must be timed to sugarbeet greater than 6-lf sugarbeet with the prospect that weed escapes range from 2- to 4-inches. We learned in 2021 that producers are willing to sacrifice sugarbeet safety to control weed escapes. Further research is needed to improve spray quality including selection of nozzles and spray volume to optimize weed control.

Appendix.

2021 Ultra Blazer Section 18 Emergency Exemption

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 from Ultra Blazer?

   None Slight Moderate Severe

4. Record weed control from Ultra Blazer in sugarbeet?

   Excellent Good Fair Poor

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 2022?

   YES NO.

Write comments to provide additional details regarding your experiences.

____

____

____

WATERHEMP CONTROL FROM SOIL RESIDUAL HERBICIDES IN A DRY SEASON

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Summary

1. Shallow incorporation of ethofumesate reduces degradation losses.
2. Soil residual herbicides control weeds when they are incorporated into the soil solution.
3. Time application of soil residual herbicides to sugarbeet growth stage rather than rainfall events.
4. Preemergence (PRE) application followed by a split layby application of soil residual herbicides is our best waterhemp control strategy.
5. A third postemergence (POST) application of chloroacetamide herbicide tends to improve waterhemp control but causes increased sugarbeet injury.

Introduction

Waterhemp control in sugarbeet is our most important weed management challenge. Waterhemp is both common and troublesome in fields planted to sugarbeet for multiple reasons. First, sugarbeet is botanically related to waterhemp. Sugarbeet is a member of the Betoidae subfamily within Amaranthaceae which includes approximately 2,500 species. Second, waterhemp are small seeded broadleaf weeds, germinating and emerging near the soil surface in response to moisture and light from May through August. Third, waterhemp are prolific seed producers, capable of producing between 50,000 and 250,000 seeds depending on emergence date, plant size, and competition with the surrounding cultivated crop. Fourth, waterhemp has male and female flowers on separate plants (dioecious). That is, male plants produce pollen while female plants make seed. This unique biology creates tremendous genetic diversity in populations and results in plants that are biologically and morphologically unique. Moreover, waterhemp has a remarkable ability to adapt to control tactics and has evolved resistance to herbicides from many different classes. To date, waterhemp has evolved 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). Finally, waterhemp seeds are viable for up to six years in the soil.

The foundation of the waterhemp control program in sugarbeet has been 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.

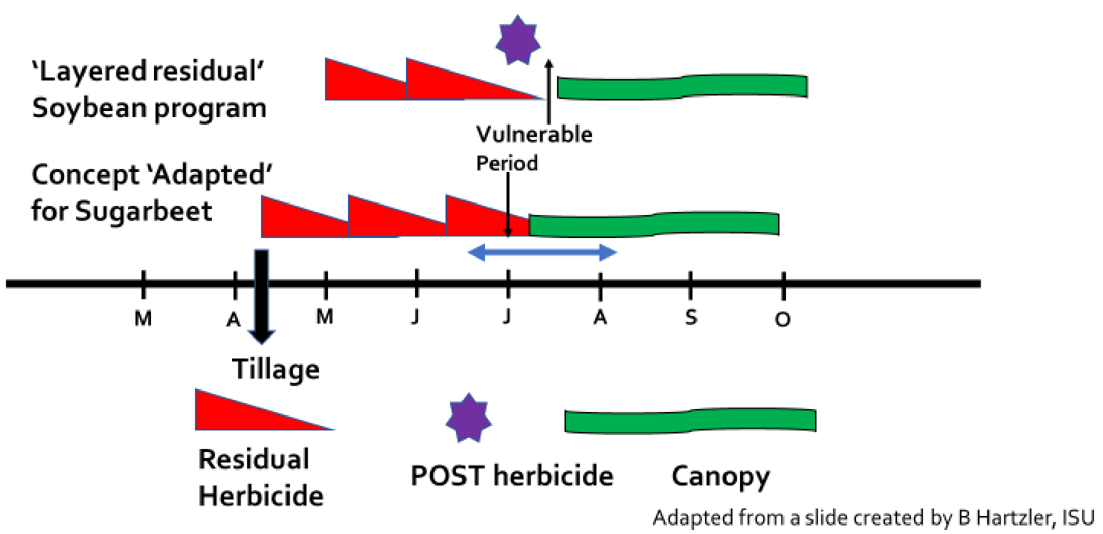

Figure 1. A demonstration of layered soil residual herbicides creating a herbicide barrier in soil from planting through canopy closure.

Our recommendations were developed from experiments conducted in 2014, 2015, and 2016 or seasons when timely rainfall incorporated soil residual herbicide into the soil shortly after application. These trials support a PRE application followed by split lay-by applications (Figure 2). Rainfall has been both localized and sporadic in 2020 and 2021 resulting in early season waterhemp escapes. Further, some producers have questioned if it makes economic sense to apply soil residual herbicides according to sugarbeet growth stage when rain is not in the forecast. Our continued research experiments, specifically 2020 experiments, like producer fields, did not received timely rainfall. The objective of this report is to discuss the performance of herbicides when inadequate activation from rainfall results in the herbicide remaining on the soil surface for days or weeks following application.

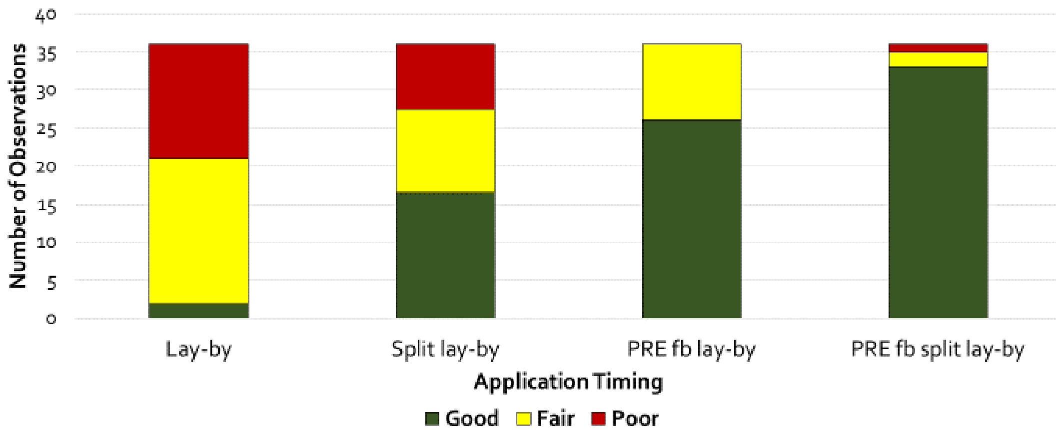

Figure 2. Number of observations with good (greater than 85%), fair (65% to 84%), and poor (less than 64%) waterhemp control in response to herbicide treatment and application timing summed across evaluations and locations, 2014 to 2016.

Materials and Methods

Waterhemp control with ethofumesate

Experiments were conducted near Blomkest and Moorhead, MN in 2020 and near Fargo, ND and Moorhead, MN in 2021. The experimental area was prepared for planting by fertilizing and conducting tillage across the experimental area. Sugarbeet was planted on April 25 and May 3 at Blomkest and Moorhead, respectively, in 2020 and May 10 and May 12 at Fargo and Moorhead, respectively, in 2021. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.5 inch spacing between seeds. Herbicide treatments for 2020 experiment at Blomkest and Moorhead are found in Table 1 and herbicide treatments for the 2021 experiment at Fargo and Moorhead are found in Table 2.

Table 1. Herbicide treatments and rate, Blomkest and Moorhead, MN, 2020.

Herbicide Treatment	Application Timing	Rate (pt/A)
Untreated Check		0
Ethofumesate	Preemergence	1.5
Ethofumesate	Preemergence	3
Ethofumesate	Preemergence	4.5
Ethofumesate	Preemergence	6
Ethofumesate	Preemergence	7.5

Table 2. Herbicide treatment, application timing, and rate, Fargo, ND and Moorhead, MN, 2021.

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

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 2020 and 2021. Visible waterhemp control (0 to 100% control, 0% indicating no control, and 100% indicating complete control) was collected approximately 14, 28, 42, 56, and 70 days after treatment (DAT). Experimental design was randomized complete block with four replications in 2020 and randomized complete block design with four replications in a factorial treatment arrangement in 2021, with factors being herbicide treatment and application timing. Data were analyzed with the ANOVA procedure of ARM, version 2021.2 software package.

Waterhemp control with soil residual herbicides applied PRE and POST

Experiments were conducted near Blomkest and Moorhead, MN in 2021. Treatments are listed in Table 3. The experimental area was prepared for planting by fertilizing and conducting tillage across the experimental area. Sugarbeet was planted on May 3 at Blomkest and May 12 at Moorhead in 2021. Sugarbeet was seeded in 22-inch rows at approximately 63,500 seeds per acre with 4.5 inch spacing between seeds. 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.

Table 3. Herbicide treatment, rate, and application timing, Blomkest and Moorhead, MN, 2021.

Herbicide Treatment PRE	Residual Herbicide Treatment POST[a]	Rate (pt/A)	Sugarbeet stage (lvs)
No	Untreated Check		-
No	Warrant	3	2
No	Outlook / Outlook	0.75 / 0.75	2 / 8
No	Warrant / Warrant	3 / 3	2 / 8
No	Outlook / Warrant	0.75 / 3	2 / 8
No	Outlook / Warrant	0.75 / 4	2 / 8
No	Outlook / Warrant / Warrant	0.75 / 3 / 3	2 / 4 / 8
Etho + DM[b]	Untreated Check	2 + 0.5	PRE
Etho + DM	Warrant	2 + 0.5 / 3	PRE / 2
Etho + DM	Outlook / Outlook	2 + 0.5 / 0.75 / 0.75	PRE / 2 / 8
Etho + DM	Warrant / Warrant	2 + 0.5 / 3 / 3	PRE / 2 / 8
Etho + DM	Outlook / Warrant	2 + 0.5 / 0.75 / 3	PRE / 2 / 8
Etho + DM	Outlook / Warrant	2 + 0.5 / 0.75 / 4	PRE / 2 / 8
Etho + DM	Outlook / Warrant / Warrant	2 + 0.5 / 0.75 / 3 / 3	PRE / 2 / 4 / 8
Ethofumesate	Untreated Check	6	PRE
Ethofumesate	Warrant	6 / 3	PRE / 2
Ethofumesate	Outlook / Outlook	6 / 0.75 / 0.75	PRE / 2 / 8
Ethofumesate	Warrant / Warrant	6 / 3 / 3	PRE / 2 / 8
Ethofumesate	Outlook / Warrant	6 / 0.75 / 3	PRE / 2 / 8
Ethofumesate	Outlook / Warrant	6 / 0.75 / 4	PRE / 2 / 8
Ethofumesate	Outlook / Warrant / Warrant	6 / 0.75 / 3 / 3	PRE / 2 / 4 / 8

[a]Roundup PowerMax at 28 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, including untreated check.
[b]Etho + DM = ethofumesate + Dual Magnum

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). Visible waterhemp control was evaluated using a 0 to 100% scale (0% indicating no control and 100% indicating complete weed control) were collected approximately 14, 28, 42, 56, and 70 DAT. 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 2021.2 software package.

Results

Waterhemp control with ethofumesate

Rainfall totals for Blomkest and Moorhead, MN and Fargo, ND from April through August in 2020 and 2021 along with 30-yr averages are presented in Table 4. The number of days between ethofumesate application and the first significant rainfall for incorporating ethofumesate into soil were 1-day at Moorhead in 2020, 21 days at Blomkest in 2020, and 28 days at Fargo in 2021. Data will not be included from Moorhead 2021 due to a combination of extremely dry conditions in May and poor sugarbeet emergence which compromised the quality of the experiment.

Table 4. Monthly rainfall totals in 2020 and 2021 and 30-yr averages, Blomkest and Moorhead, MN and Fargo, ND.[a]

	Blomkest, MN			Fargo, ND			Moorhead, MN		
Month	2020	2021	Avg.[b]	2020	2021	Avg.	2020	2021	Avg.
	Inch								
April	1.6	1.8	2.6	4.5	1.5	1.3	5.4	2.3	1.6
May	2.1	1.4	3.1	1.5	0.9	2.8	1.6	0.7	3.2
June	4.9	1.3	4.8	3.5	3.3	4.1	3.8	4.6	4.1
July	3.9	1.7	3.7	5.9	0.9	2.8	5.3	0.9	3.2
August	4.5	5.0	3.8	5.8	3.9	2.6	5.8	3.7	2.7

[a]Data compiled from NOAA, Climate Corp, and/or NDAWN.
[b]Avg. = 30-year average.

Waterhemp control was influenced by ethofumesate rate and number of days after ethofumesate application at Moorhead and Blomkest (Figures 3 and 4). Waterhemp control from up to 7.5 pt/A of ethofumesate was less than 80% at Moorhead in 2020, regardless of receiving 0.6 inches of rain the day after application.

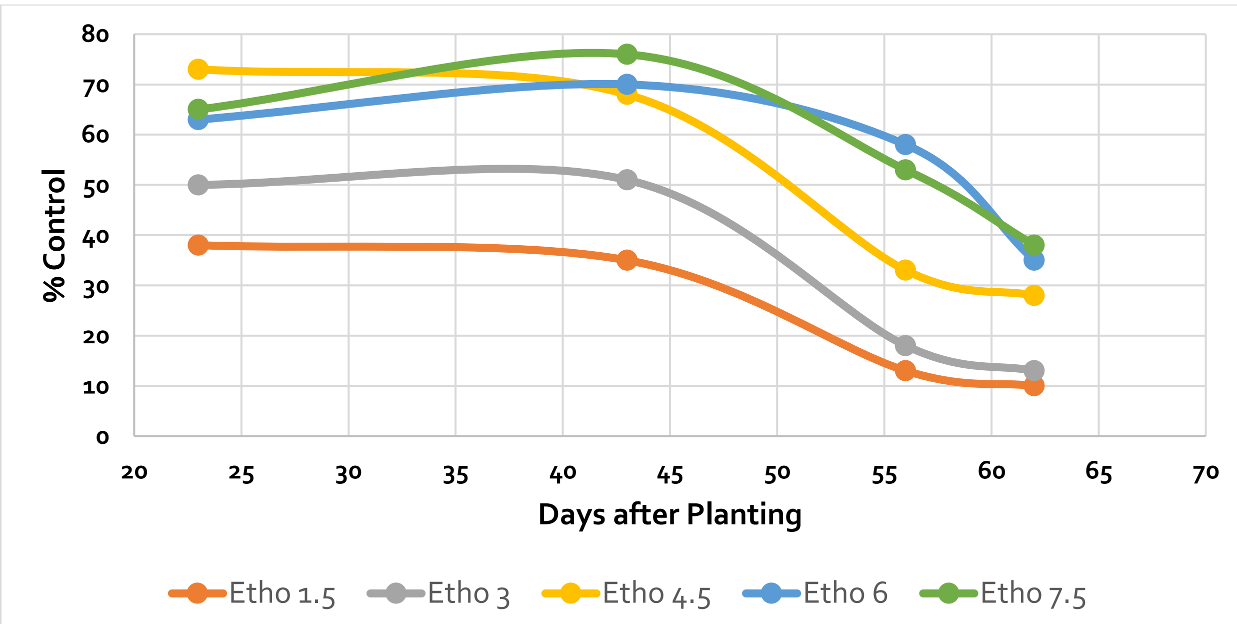

Figure 3. Visible waterhemp control 23 to 63 days after planting (DAP) in response to ethofumesate rate, Moorhead, MN, 2020.

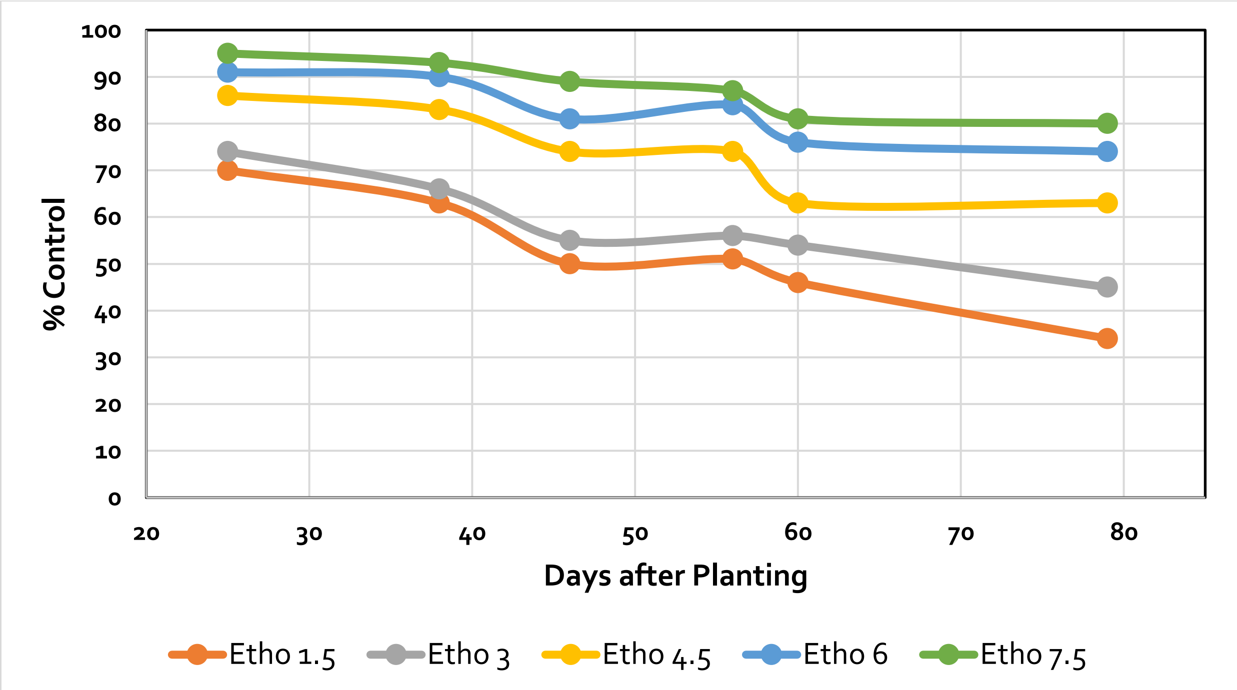

Figure 4. Visible waterhemp control 25 to 80 days after planting (DAP) in response to ethofumesate rate, Blomkest, MN, 2020.

Ethofumesate at 4.5, 6.0, and 7.5 pt/A provided up to 85% waterhemp control at Blomkest. However, ethofumesate at 1.5 and 3 pt/A provided less than 75% control. Waterhemp control results from Moorhead and Blomkest challenges the viability of ethofumesate PRE at 2 pt/A. Sub-lethal rates provide waterhemp control for a short duration or until an application of soil residual herbicides POST can be applied to sugarbeet. These data suggest sub-lethal rates are providing less than full waterhemp control, even for this short duration.

There were challenges in activating ethofumesate at the Fargo location in 2021, even with applying ethofumesate PPI. We observed differences in early and late germinating waterhemp control (Figure 5) based on application method. Ethofumesate applied PRE provided greater waterhemp control on early germinating waterhemp while ethofumesate applied PPI provided greater control on late germinating waterhemp.

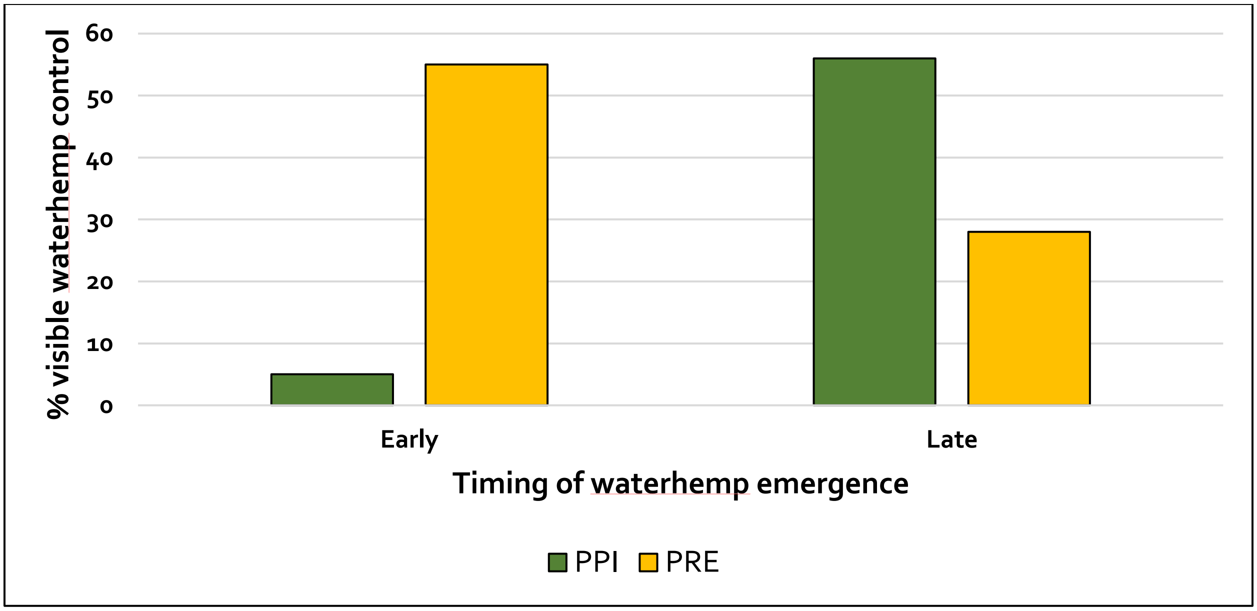

Figure 5. Early and late germinating waterhemp control in response to ethofumesate PPI and PRE, Fargo, 2021.

McAuliffe and Appleby (1984) reported ethofumesate tightly adsorbs to soil colloids and is susceptible to rapid degradation in dry soils. We believe some of the waterhemp control challenges we have observed in both our research and in commercial fields is related to chemical properties of ethofumesate as compared with chloroacetamide herbicides. For example, the ratio of herbicide bound to soil colloids (K_{OC}) versus herbicide in the soil solution is two-fold greater with ethofumesate than dimethenamid-P. In addition, dimethenamid-P water solubility is 10 times greater than ethofumesate. Although ethofumesate was incorporated after application in this study, its concentration was diluted by incorporation and tightly bound to soil colloids rendering it unavailable for waterhemp control. Control of late season waterhemp was improved since ethofumesate desorbed from soil and moved into the soil solution following rainfall events. In this experiment, ethofumesate PRE was partially incorporated into soil solution and made available for seedling uptake as a result of a 0.4-inch rainfall on May 10. The remaining ethofumesate PRE likely degraded and was unavailable for control of late emerging waterhemp, especially at the lower rates.

Waterhemp control with soil residual herbicides applied PRE and POST

A 0.8-inch rain event was measured on May 27 at Blomkest or 16 days after PRE application and 2 days after POST application to sugarbeet at the 2-lf stage (Table 5). A second 0.8-inch rainfall event was measured on June 28, or 18 days after 8-lf stage, 28 days after 4-lf stage, and 34 days after 2-lf stage application. Sugarbeet injury and waterhemp control were evaluated weekly between June 3 and July 15. Data collected June 12, June 25, and July 7 will be considered in this report. PRE treatment did not interact with POST treatment (Table 6). Thus, PRE treatment (no PRE, ethofumesate plus Dual Magnum, or ethofumesate) were averaged across POST treatment.

Sugarbeet visible growth reduction injury was evaluated 18 days after the 2-lf sugarbeet stage application. Sugarbeet injury from Warrant following Warrant or repeat Warrant applications following Outlook injured sugarbeet more than the untreated check treatment (Table 7). In addition, there were more incidents of greater than 30% sugarbeet injury in Warrant followed by Warrant or Outlook followed by Warrant followed by Warrant plots as compared with other POST treatments.

Table 5. Application information, Blomkest, MN 2021.

Date	May 11	May 25	June 1	June 10
Time of Day	9:40 AM	6:50 AM	12:40 PM	8:50 AM
Air Temperature (F)	53	70	73	82
Relative Humidity (%)	26	83	29	55
Wind Velocity (mph)	2	9	0	10
Wind Direction	W	S	-	SW
Soil Temp. (F at 6”)	47	66	67	75
Soil Moisture	Dry	Dry	Dry	Dry
Cloud Cover (%)	0	20	20	50
Sugarbeet Stage	PRE	2-lf	4-lf	8-lf
Waterhemp Height	-	0.5 inch	0.5 inch	1 inch

Table 6. Source of variation and P-values for sugarbeet injury and waterhemp control in response to treatment, Blomkest, MN, 2021.

	Sugarbeet Injury	Waterhemp Control		
Source of Variation	June 12	June 12	June 25	July 7
	-------------------------------*P-Value*----------------------------------			
Preemergence	0.0118	0.0917	0.0001	0.0001
Postemergence	0.0006	0.0001	0.0021	0.0001
Preemergence × Postemergence	0.9281	0.8540	0.6652	0.2340

Table 7. Sugarbeet visible injury, plots with 30% or greater injury, and visible waterhemp control from POST residual treatments averaged across PRE treatment, Blomkest, MN, 2021.[a]

		Sugarbeet Injury		Waterhemp Control		
Soil Residual Treatment POST[b]	Rate	18 DAT[c]		18 DAT[c]	31 DAT[c]	43 DAT[c]
	--pt/A--	--%--	--Num[d]--	-------------------%-------------------		
Untreated Check		8 bc	2	85 d	85 c	79 c
Outlook / Outlook	0.75 / 0.75	10 bc	3	95 ab	92 ab	88 ab
Warrant / Warrant	3 / 3	17 ab	12	86 d	89 bc	88 ab
Outlook / Warrant	0.75 / 3	8 bc	4	92 bcd	90 abc	89 ab
Outlook / Warrant	0.75 / 4	3 c	3	94 abc	91 abc	92 a
Outlook / Warrant / Warrant	0.75 / 3 / 3	22 a	14	99 a	96 a	95 a
LSD (0.10)		10		6	6	7

[a]Means not sharing any letter are significantly different at the 10% level of significance.
[b]Roundup PowerMax at 28 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC HSMOC at 1.5 pt/A + Amsol Liquid at 2.5% v/v was applied with all POST treatments, including untreated check.
[c]Days after 2- to 4-lf stage application.
[d]Number of plots out of 24 with 30% or greater visible sugarbeet growth reduction injury.

Waterhemp control was greatest from Outlook at 18 days after 2-lf sugarbeet application. Outlook is more water soluble than Warrant and likely moved into the soil more efficiently with limited rainfall. Soil residual herbicide treatments applied EPOST, POST, and LPOST was activated from the June 28 rainfall event and provided waterhemp control greater than repeat Roundup PowerMax plus ethofumesate applications.

The Blomkest experiment received 1.8-inches total rainfall in May and June. Even under these drought conditions, chloroacetamide herbicides controlled waterhemp. Outlook at the 2-lf stage, averaged across PRE treatments, provided waterhemp control greater than Warrant at the 2-lf stage or repeat applications of Roundup PowerMax plus ethofumesate. However, chloroacetamide herbicides were equally as effective at controlling waterhemp 31 and 43 days after the 2-lf stage application. Outlook followed by repeat Warrant applications (totaling 3 POST treatments) provided greater numeric waterhemp control than 2-lf POST treatments, but injured sugarbeet more than the other POST treatments.

Postemergence treatment evaluations were averaged across PRE treatments (Table 8). Ethofumesate PRE at 6 pt/A and ethofumesate + Dual Magnum PRE at 2 pt + 0.5 pt/A, respectively, averaged across POST treatments had greater sugarbeet injury than no PRE. Preemergence treatments caused greater than 30% sugarbeet injury in more plots compared to no PRE when averaged across POST treatments. However, this sugarbeet injury is considered negligible. Preemergence treatments averaged across POST treatments controlled waterhemp greater than no PRE treatments, even in drought conditions.

Table 8. Sugarbeet visible injury, plots with 30% or greater injury, and visible waterhemp control from PRE treatments averaged across POST treatment, Blomkest, MN, 2021.[a]

		Sugarbeet Injury		Waterhemp Control		
Soil Residual treatment PRE[b]	Rate	32 DAP[c]		32 DAP	45 DAP	57 DAP
	--pt/A--	--%--	--Num[d]--	------------------%------------------		
None	-	7 b	8	89 b	85 b	83 b
Ethofumesate + Dual Magnum	2 + 0.5	13 a	18	93 a	91 a	89 a
Ethofumesate	6	15 a	20	92 a	94 a	91 a
LSD (0.10)		5		3	3	3

[a]Means not sharing any letter are significantly different at the 10% level of significance.
[b]Roundup PowerMax at 28 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC HSMOC at 1.5 pt/A + Amsol Liquid at 2.5% v/v was applied with all POST treatments, including 'none'.
[c]DAP = Days after planting.
[d]Num = Total number out of 56 plots with 30% or greater visible sugarbeet growth reduction injury.

The Moorhead experiment was planted into dry soil. The first 'herbicide incorporating' rain did not occur until June 7, 26 DAP or 6 days after the 2-lf sugarbeet stage application (Table 9). The Moorhead site received 4.6-inches total rainfall in June that activated soil residual herbicides. Waterhemp control data collected on June 27, July 17, and July 27 will be discussed in this report. Sugarbeet injury from herbicide treatments will not be presented as we observed stand challenges throughout the season. Preemergence treatments interacted with POST treatments for waterhemp control evaluations collected on June 27 and July 17 (Table 10). However, the interaction can largely be explained by waterhemp control from repeat applications of Roundup PowerMax plus ethofumesate with or without PRE herbicides. Thus, a discussion of PRE treatment (no PRE, ethofumesate plus Dual Magnum, or ethofumesate) averaged across POST treatments along with a discussion of POST applied soil residual herbicides averaged across PRE treatment will be emphasized in this report.

Table 9. Application information, Moorhead, MN 2021.

Date	May 12	June 1	June 9	June 22
Time of Day	5:00 PM	1:00 PM	9:00 AM	12:00 PM
Air Temperature (F)	75	77	80	75
Relative Humidity (%)	23	29	58	42
Wind Velocity (mph)	4	6	7	3
Wind Direction	S	SE	SE	S
Soil Temp. (F at 6")	60	66	70	70
Soil Moisture	Dry	Dry	Wet	Wet
Cloud Cover (%)	20	80	100	20
Sugarbeet Stage	PRE	2-lf	4-lf	8-lf
Waterhemp Height	-	0.5 inch	0.5 inch	1 inch

Table 10. Source of variation and P-values for waterhemp control in response to treatment, Moorhead, MN, 2021.

	Waterhemp Control		
Source of Variation	June 27	July 17	July 27
	-------------------------------	*P-value*	-------------------------------
Preemergence	0.0002	0.0003	0.0007
Postemergence	0.0001	0.0001	0.0001
Preemergence × Postemergence	0.0566	0.0391	0.5459

Soil residual herbicides applied at the 2-, 4-, and 8-lf stage, averaged across PRE treatment, provided waterhemp control greater than repeat Roundup PowerMax plus ethofumesate applications (Table 11). Outlook followed by repeat Warrant applications tended to provide greater waterhemp control than other treatments as time progressed. However, sugarbeet injury tended to increase with this treatment at Blomkest. The benefit of soil residual herbicides increased from 26 to 47 days after the 2-lf stage application. Likewise, waterhemp control was greater from PRE treatments, averaged across POST treatments, as compared with no PRE treatment (Table 12).

Table 11. Visible waterhemp control from POST residual treatments averaged across all PRE treatments, Moorhead, MN, 2021.[a]

		Waterhemp Control		
Soil Residual Treatment POST[b]	Rate	26 DAT[c]	40 DAT	47 DAT
	--pt /A--	----------------------------	%	----------------------------
None	-	76 c	49 c	31 d
Outlook / Outlook	0.75 / 0.75	96 a	89 a	84 ab
Warrant / Warrant	3 / 3	94 ab	89 a	81 b
Outlook / Warrant	0.75 / 3	95 ab	92 a	87 ab
Outlook / Warrant	0.75 / 4	98 a	91 a	89 ab
Outlook / Warrant / Warrant	0.75 / 3 / 3	98 a	95 a	93 a
LSD (0.10)		5	10	12

[a]Means not sharing any letter are significantly different at the 10% level of significance.
[b]Roundup PowerMax at 28 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC HSMOC at 1.5 pt/A + Amsol Liquid at 2.5% v/v was applied with all POST treatments, including 'none'.
[c]DAT = Days after 2- to 4-lf stage application.

Table 12. Visible waterhemp control from PRE treatments averaged across all POST treatments, Moorhead, MN, 2021.[a]

		Waterhemp Control		
Soil Residual Treatment PRE[b]	Rate	46 DAP[c]	66 DAP	76 DAP
	(pt /A)	-----------------------	%	-----------------------
None	-	89 b	76 b	67 b
Ethofumesate + Dual Magnum	2 + 0.5	93 a	84 a	78 a
Ethofumesate	6	95 a	87 a	79 a
LSD (0.10)		3	5	6

[a]Means not sharing any letter are significantly different at the 10% level of significance.
[b]Roundup PowerMax at 28 fl oz/A + ethofumesate at 6 fl oz/A + Destiny HC HSMOC at 1.5 pt/A + Amsol Liquid at 2.5% v/v was applied with all POST treatments, including 'none'.
[c]DAP = Days after Plant.

Conclusion

Soil residual herbicides are the best strategy for waterhemp control in sugarbeet. We recommend producers follow the program and use soil residual herbicides PRE, EPOST, and POST to control waterhemp in sugarbeet, regardless of moisture conditions. Ethofumesate is often tank mixed with Dual Magnum (24c local needs label) PRE which enables some early season weed control in the event that ethofumesate is not incorporated into the soil by rainfall. Producers are considering greater ethofumesate rates along with pre-plant incorporation (PPI) at application. We recommend shallow incorporation (suitable to move ethofumesate into the surface 1-inch of soil) of ethofumesate and use rates greater than 3 pt/A to ensure ethofumesate is not diluted by incorporation. Finally, we recommend applying *S*-metolachlor (Dual Magnum, Brawl, Charger Basic, Medal, Mocassin, etc.), Outlook, or Warrant at the 2- to 4- and 6- to 8-lf stage. The idea of a third lay-by treatment (2-/4-/8-lf stage vs. 2- to 4- and 6- to 8-lf stage) tended to improve waterhemp control at Moorhead and Blomkest; however, increased sugarbeet injury at Blomkest.

References

1. McAuliffe, D., and Appleby, A.P. 1984. Activity loss of ethofumesate in dry soil by chemical degradation and Adsorption. Weed Sci. 32:468-471

Appendix. Trials conducted in the SMBSC growing area but not reported in the 2021 Research Reports.

Trial	Location	Description
Aphanomyces Seed Treatment Trial	Renville	This trial evaluated the effectiveness of a new seed treatment products to control Aphanomyces. As a proprietary trial all data was collected and delivered to the company funding the research.
Rhizoctonia Inoculation Rate Trial	Renville	This trial evaluated the rates of post-emerge Rhizoctonia inoculum used on the Rhizoctonia nursery to aid in the targeted rate of inoculum used on the nursery to promote Rhizoctonia infection.
Rhizoctonia In furrow and Post Application Trial	Renville	This trial evaluated the effectiveness of in furrow and post applications to control rhizoctonia. Variability across the trial limited the usefulness of this data and will not be reported at this time
Pressed Liquid Dairy Manure Trial	Murdock	This trial was designed to evaluate when pressed liquid dairy manure would best be applied to benefit sugar beet production in a field corn/sugar beets/soybean crop rotation. This is a 3 year trial with only 2 years complete. As such, no data was published on this trial in 2021.
Magno Proprietary Trials (6)	Hector, Wood Lake, Murdock (2), and Lake Lillian, Aph Nursery	These variety trials are 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.