2020

RESEARCH REPORT

Southern Minnesota Beet Sugar Cooperative

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2020 SMBSC Official Variety Trial Procedures

Cody Groen

Four Official Variety Trial 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. Emergence counts were taken approximately 28 days after planting, and 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. 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 ethofumesate, Roundup Weathermax/Powermax, Dual Magnum, and Stinger at the appropriate rates and times. The weeds present at each site dictated the weed control products used at each site. 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. Eight Cercospora leafspot fungicide applications were made at each of the Official Variety 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 removed these “end-beets” 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.

All varieties were entered into various disease nurseries to evaluate the disease tolerance of the varieties. Cercospora leafspot nurseries were conducted by SMBSC at a location near Renville and at a Betaseed location near Randolph, MN. Aphanomyces root rot nurseries were conducted at Betaseed’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.

Data is summarized and merged with the previous two years of data to evaluate the varieties for approval. SMBSC Seed Policy sets out guidelines for minimum performance standards of the varieties. Varieties that meet all the approval criteria are approved for shareholders to plant their 2021 sugar beet crop.

2020 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	Yes	4/25/2020	5/28/2020	9/17/2020	Moderate APH & RHC, light CLS
Yield	Brad and Jeff Schmoll	Lake Lillian	Soybean	No	4/27/2020	6/1/2020	9/21/2020	Light APH & RHC; moderate CLS
Yield	Schwerin Farms	Wood Lake	Field Corn	No	4/22/2020	5/29/2020	10/5/2020	Small canopy, very little disease
Yield	Brett Petersen	Murdock	P.P. Wheat	No	4/30/2020	6/3/2020	9/28/2020	Large canopy, moderate to heavy CLS

Disease Nursery Trials Specifications

Trial Type	Investigator	Trial Location	Rating Performed by	Use of Ratings in 2021 Variety Approval System
Aphanomyces	SMBSC	Renville	SMBSC Staff	50% of 2020 APH Rating
Aphanomyces	Betaseed	Shakopee	Betaseed, M. Bloomquist, C. Groen, J. Brantner, A. Chanda	50% of 2020 APH Rating
Cercospora	SMBSC	Renville	SMBSC Staff	50% of 2020 CLS Rating
Cercospora	Betaseed	Randolph	Betaseed Staff	50% of 2020 CLS Rating
Rhizoctonia	SMBSC	Renville	SMBSC Staff	50% of the 2020 RHC Rating
Rhizoctonia	BSDF - USDA/ARS	Michigan	Linda Hanson and USDA/ARS Staff	50% of the 2020 RHC Rating

Table 1. Comparison of 2021 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Three Years of Data (2018-2020)

		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	
2021 Fully Approved Varieties - Three Years of Data (% of Mean is of Fully Approved Mean)																						
Beta 9780		282.8	101.9	9596.4	102.6	16.6	102.2	91.2	100.0	34.1	100.8	4.1	102.0	4.1	102.8	5.1	118.6	74.7	98.3	103.7	104.6	9780
Beta 9810		278.2	100.3	9281.8	99.2	16.4	101.0	90.7	99.5	33.6	99.4	3.2	79.1	4.1	103.2	4.2	97.7	76.5	100.8	99.9	99.3	9810
Crystal M821		279.2	100.6	8994.5	96.2	16.4	100.8	91.1	99.9	32.3	95.5	3.5	86.2	3.8	95.2	4.9	114.0	77.3	101.8	101.0	96.5	M821
Crystal M837		282.2	101.7	9383.4	100.3	16.5	101.6	91.1	99.9	33.4	98.8	4.0	99.5	4.0	99.8	4.7	109.3	73.8	97.3	102.2	101.0	M837
SV 881		274.3	98.9	9369.9	100.2	16.0	98.3	91.5	100.4	34.2	101.1	4.3	108.2	4.0	99.8	4.0	93.0	75.4	99.4	97.1	98.2	881
SV 883	RHC	274.7	99.0	9310.5	99.5	16.1	98.8	91.2	100.0	33.9	100.3	4.3	107.0	4.2	106.6	3.8	88.4	77.1	101.6	97.5	97.8	883
SV RR862	RHC	274.0	98.8	9472.2	101.3	16.0	98.7	91.4	100.2	34.6	102.3	4.4	109.5	3.8	94.8	3.8	88.4	76.7	101.0	96.8	99.1	862
SV RR863		273.8	98.7	9428.5	100.8	16.0	98.6	91.3	100.1	34.4	101.8	4.4	108.6	3.9	97.7	3.9	90.7	75.8	99.9	96.5	98.3	863
Mean of Fully Approved:		**277.4**	**100.0**	**9354.7**	**100.0**	**16.3**	**100.0**	**91.2**	**100.0**	**33.8**	**100.0**	**4.0**	**100.0**	**4.0**	**100.0**	**4.3**	**100.0**	**75.9**	**100.0**	**100.0**	**100.0**	**Mean**
2021 Specialty Approved Varieties - Three Years of Data (% of mean is of Fully Approved Mean)																						
Hilleshog 2219	RHC	281.8	101.6	8480.8	90.7	16.5	101.2	91.3	100.2	30.2	89.4	4.9	121.1	4.1	102.8	3.4	79.1	72.8	95.9	102.8	91.8	2219
Hilleshog 9739	RHC	266.2	96.0	8327.6	89.0	15.6	96.1	91.1	99.9	31.2	92.1	4.9	122.8	4.1	104.5	3.4	79.1	74.8	98.6	91.1	84.1	9739
2020 Previously Approved Varieties Not Making 2021 Approval (Last Year of Sales) - Three Years of Data (% of mean is of Fully Approved Mean)																						
Crystal M509		262.7	94.7	10075.5	107.7	15.6	95.7	90.8	99.6	38.6	114.1	4.2	103.6	4.2	105.3	4.6	107.0	79.7	105.0	90.3	103.1	M509

*__Revenue per Ton__ and **Revenue per Acre** figures were produced using the payment calculation with factors released on Nov. 25, 2020 for the 1st 2020 crop payment estimate.

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

Table 2. Comparison of 2021 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Two Years of Data (2019-2020)

		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	
2021 Fully Approved Varieties - Two Years of Data (% of Mean is of Fully Approved Mean)																						
Beta 9780		290.0	102.0	9482.8	101.8	17.0	101.7	91.5	100.0	32.8	99.9	4.1	98.6	4.1	102.8	5.3	123.3	76.7	98.3	103.8	103.8	9780
Beta 9810		285.2	100.3	9237.0	99.2	16.8	100.8	91.1	99.6	32.7	99.6	3.4	82.7	4.1	102.8	4.2	97.7	78.3	100.3	100.4	100.1	9810
Crystal M821		286.3	100.6	9015.8	96.8	16.8	101.0	91.2	99.8	31.6	96.4	3.7	88.8	3.8	95.2	5.4	125.6	78.7	100.8	100.7	97.0	M821
Crystal M837		289.9	101.9	9178.7	98.5	17.0	101.7	91.4	99.9	31.8	96.8	4.1	100.4	4.0	100.2	4.9	114.0	76.9	98.5	103.5	100.4	M837
SV 881		280.7	98.7	9301.4	99.9	16.4	98.3	91.7	100.3	33.1	100.9	4.4	107.1	4.0	100.2	3.8	88.4	78.0	99.9	97.2	98.1	881
SV 883	RHC	280.0	98.4	9267.1	99.5	16.5	98.7	91.4	99.9	33.1	100.8	4.4	105.9	4.2	105.3	3.6	83.7	79.0	101.2	97.6	98.5	883
SV RR862	RHC	281.7	99.0	9482.4	101.8	16.5	98.9	91.6	100.1	33.6	102.5	4.5	110.1	3.7	94.5	3.5	81.4	77.6	99.5	98.2	100.5	862
SV RR863		282.0	99.1	9554.9	102.6	16.5	98.8	91.7	100.3	33.8	103.1	4.4	106.5	3.9	99.0	3.7	86.0	79.3	101.6	98.4	101.4	863
Mean of Fully Approved:		**284.5**	**100.0**	**9315.0**	**100.0**	**16.7**	**100.0**	**91.4**	**100.0**	**32.8**	**100.0**	**4.1**	**100.0**	**3.9**	**100.0**	**4.3**	**100.0**	**78.1**	**100.0**	**100.0**	**100.0**	**Mean**
2021 Test Market Varieties for Limited Sales - Two Years of Data (% of mean is of Fully Approved Mean)																						
Beta 9935		296.4	104.2	9279.5	99.6	17.3	103.8	91.5	100.1	31.5	96.0	4.4	106.5	3.9	98.3	4.6	107.0	79.5	101.8	107.3	103.1	9935
Crystal M977		283.0	99.5	9936.7	106.7	16.4	98.6	92.2	100.8	35.2	107.2	3.9	95.5	4.3	108.5	3.2	74.4	76.8	98.4	98.5	105.7	M977
Hilleshog 2327		282.3	99.2	9667.9	103.8	16.5	99.0	91.9	100.5	34.2	104.2	4.4	107.7	4.0	100.9	3.8	88.4	76.4	97.9	98.9	103.1	2327
SV 894		278.5	97.9	9445.0	101.4	16.3	98.0	91.5	100.1	33.9	103.2	4.4	107.1	4.2	106.6	3.5	81.4	77.2	98.9	95.5	98.7	894
2021 Specialty Approved Varieties - Two Years of Data (% of mean is of Fully Approved Mean)																						
Beta 9986	CLS	276.3	97.1	9573.1	102.8	16.2	97.2	91.6	100.2	34.5	105.2	4.2	101.0	2.0	51.4	4.3	100.0	81.9	104.9	94.6	99.5	9986
Beta 9952	CLS	277.3	97.5	8849.8	95.0	16.3	97.5	91.5	100.1	31.9	97.2	4.1	100.4	2.9	73.6	2.9	67.4	75.3	96.5	95.5	92.9	9952
Crystal M951	CLS	273.5	96.1	10017.4	107.5	16.0	96.2	91.5	100.0	36.5	111.1	4.9	118.0	2.2	54.6	4.7	109.3	78.5	100.6	92.0	102.4	M951
Hilleshog 9739	RHC	272.7	95.9	8308.7	89.2	16.1	96.3	91.3	99.8	30.4	92.6	4.9	119.2	4.1	104.7	3.0	69.8	75.6	96.8	92.7	85.9	9739
Hilleshog 2219	RHC	291.1	102.3	8457.1	90.8	16.9	101.6	91.7	100.3	29.1	88.7	4.8	116.8	4.1	102.8	3.1	72.1	72.2	92.5	103.1	91.5	2219
2020 Previously Approved Varieties Not Making 2021 Approval (Last Year of Sales) - Two Years of Data (% of mean is of Fully Approved Mean)																						
Crystal M509		269.1	94.6	9988.9	107.2	15.9	95.6	91.1	99.6	37.4	113.8	4.3	104.6	4.2	106.6	4.7	109.3	80.3	102.9	89.8	102.4	M509

*__Revenue per Ton__ and __Revenue per Acre__ figures were produced using the payment calculation with factors released on Nov. 25, 2020 for the 1st 2020 crop payment estimate.

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

Table 3. Comparison of 2021 Fully Approved Varieties to Test Market and Specialty Approved Varieties - One Year Data (2020)

		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	
2021 Fully Approved Varieties - One Year of Data (% of Mean is of Fully Approved Mean)																						
Beta 9780		286.5	101.3	10104.4	101.6	17.1	101.7	90.0	99.7	35.4	100.5	4.1	98.4	4.1	101.9	4.7	108.0	73.0	95.0	101.8	102.4	9780
Beta 9810		281.3	99.5	9828.0	98.8	16.8	99.9	89.9	99.7	35.0	99.4	3.5	82.8	4.0	99.4	4.3	98.9	76.9	100.1	98.0	97.5	9810
Crystal M821		283.9	100.4	9530.9	95.9	17.0	100.7	90.0	99.8	33.9	96.1	3.8	91.2	3.8	94.4	4.6	105.7	75.9	98.7	100.6	96.9	M821
Crystal M837		285.3	100.9	9973.5	100.3	17.0	101.1	90.0	99.8	35.1	99.5	4.4	105.5	4.0	99.4	4.7	108.0	77.5	100.9	100.6	100.3	M837
SV 881		280.8	99.3	9862.9	99.2	16.7	99.1	90.5	100.3	35.2	99.8	4.3	101.9	4.2	104.3	4.3	98.9	76.1	99.0	98.5	98.5	881
SV 883	RHC	280.3	99.1	9930.5	99.9	16.7	99.2	90.2	100.0	35.4	100.4	4.3	101.9	4.3	106.8	4.1	94.3	81.1	105.6	97.7	98.2	883
SV RR862	RHC	281.4	99.5	10238.1	103.0	16.7	99.0	90.6	100.4	36.4	103.3	4.6	110.3	3.7	91.9	4.0	92.0	74.5	97.0	98.7	102.1	862
SV RR863		282.2	99.8	10079.6	101.4	16.8	99.5	90.5	100.3	35.6	101.0	4.5	107.9	4.1	101.9	4.1	94.3	79.6	103.6	99.6	100.8	863
Mean of Fully Approved:		**282.7**	**100.0**	**9943.5**	**100.0**	**16.9**	**100.0**	**90.2**	**100.0**	**35.2**	**100.0**	**4.2**	**100.0**	**4.0**	**100.0**	**4.4**	**100.0**	**76.8**	**100.0**	**100.0**	**100.0**	**Mean**
2021 Test Market Varieties - One Year of Data (% of mean is of Fully Approved Mean)																						
Beta 9935		289.9	102.5	9833.5	98.9	17.3	102.7	90.0	99.8	33.9	96.3	4.5	106.7	4.0	99.4	4.5	103.4	77.5	100.8	104.1	100.3	9935
Beta 9098		283.7	100.3	10419.8	104.8	16.9	100.2	90.3	100.1	37.0	104.9	4.9	116.3	2.7	67.1	4.4	101.1	76.7	99.9	100.3	105.4	9098
Crystal M977		278.5	98.5	10514.5	105.7	16.5	97.8	90.8	100.7	37.9	107.5	4.0	96.0	4.6	114.3	3.8	87.4	77.3	100.6	96.9	104.3	M977
Crystal M002		281.2	99.5	10322.7	103.8	16.7	99.3	90.3	100.1	36.7	104.2	4.1	98.4	2.1	52.2	4.5	103.4	80.3	104.6	97.9	102.1	M002
Hilleshog 2327		282.1	99.8	10158.4	102.2	16.7	99.2	90.7	100.5	36.0	102.3	4.2	100.7	4.2	104.3	4.1	94.3	75.2	97.9	99.0	101.3	2327
SV 894		276.9	97.9	10033.2	100.9	16.5	97.9	90.4	100.2	36.2	102.8	4.6	109.1	4.4	109.3	4.0	92.0	77.2	100.5	95.9	98.6	894
2021 Specialty Approved Varieties - One Year of Data (% of mean is of Fully Approved Mean)																						
Beta 9986	CLS	272.4	96.3	10197.7	102.6	16.3	96.7	90.1	99.9	37.3	105.8	4.3	103.1	2.3	57.1	4.3	98.9	81.0	105.4	92.7	98.3	9986
Beta 9952	CLS	274.2	97.0	9470.2	95.2	16.3	96.8	90.4	100.2	34.6	98.3	4.1	98.4	2.8	69.6	3.4	78.2	74.5	97.0	93.5	91.9	9952
Crystal M951	CLS	271.4	96.0	10520.8	105.8	16.3	96.7	89.9	99.6	38.7	109.7	5.2	123.5	2.4	59.6	4.6	105.7	76.7	99.8	92.2	101.4	M951
Hilleshog 9739	RHC	274.1	97.0	9247.6	93.0	16.4	97.4	90.0	99.8	33.8	96.0	4.9	116.3	4.2	104.3	3.6	82.8	74.0	96.4	93.6	89.9	9739
Hilleshog 2219	RHC	290.7	102.8	9391.6	94.4	17.3	102.6	90.3	100.1	32.4	92.1	4.8	115.1	4.2	104.3	3.5	80.5	73.1	95.1	105.0	96.6	2219
2020 Previously Approved Varieties Not Making 2021 Approval (Last Year of Sales) - One Year of Data (% of mean is of Fully Approved Mean)																						
Crystal M509		265.5	93.9	10736.3	108.0	16.0	94.9	89.8	99.5	40.8	115.8	4.2	99.6	4.4	109.3	4.1	94.3	78.3	102.0	88.4	102.5	M509

*__Revenue per Ton__ and __Revenue per Acre__ figures were produced using the payment calculation with factors released on Nov. 25, 2020 for the 1st 2020 crop payment estimate.

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

2018 - 2020 Disease Nursery Data for Aphanomyces, Cercospora, and Rhizoctonia

	Aphanomyces Root Ratings					Cercospora Leafspot Ratings					Rhizoctonia Root Ratings				
	2020	2019	2018	**2019-2020**	**2018-2020**	2020	2019	2018	**2019-2020**	**2018-2020**	2020	2019	2018	**2019-2020**	**2018-2020**
Variety	Root	Root	Root	**2 Year Mean**	**3 Year Mean**	CLS	CLS	CLS	**2 Year Mean**	**3 Year Mean**	Root	Root	Root	**2 Year Mean**	**3 Year Mean**
Description	Rating	Rating	Rating	Root Rating	Root Rating	Rating	Rating	Rating	Foliar Rating	Foliar Rating	Rating	Rating	Rating	Root Rating	Root Rating
Fully Approved Varieties															
Beta 9780	4.1	4.0	4.2	4.1	4.1	4.1	4.0	4.1	4.1	4.1	4.7	5.8	4.7	5.3	5.1
Beta 9810	3.5	3.4	2.7	3.4	3.2	4.0	4.1	4.2	4.1	4.1	4.3	4.0	4.3	4.2	4.2
Crystal M821	3.8	3.5	3.1	3.7	3.5	3.8	3.7	3.8	3.8	3.8	4.6	6.2	4.0	5.4	4.9
Crystal M837	4.4	3.9	3.7	4.1	4.0	4.0	3.9	4.0	4.0	4.0	4.7	5.1	4.3	4.9	4.7
SV 881	4.3	4.6	4.2	4.4	4.3	4.2	3.7	4.0	4.0	4.0	4.3	3.3	4.3	3.8	4.0
SV 883 (RHC)	4.3	4.5	4.2	4.4	4.3	4.3	4.0	4.4	4.2	4.2	4.1	3.0	4.2	3.6	3.8
SV RR862 (RHC)	4.6	4.5	4.1	4.5	4.4	3.7	3.8	3.8	3.7	3.8	4.0	2.9	4.4	3.5	3.8
SV RR863	4.5	4.3	4.3	4.4	4.4	4.1	3.7	3.8	3.9	3.9	4.1	3.3	4.3	3.7	3.9
Test Market Varieties															
Beta 9935	4.5	4.3		4.4		4.0	3.8		3.9		4.5	4.6		4.6	
Beta 9098	4.9					2.7					4.4				
Crystal M977	4.0	3.9		3.9		4.6	4.0		4.3		3.8	2.5		3.2	
Crystal M002	4.1					2.1					4.5				
Hilleshog 2327	4.2	4.7		4.4		4.2	3.8		4.0		4.1	3.5		3.8	
SV 894	4.6	4.3		4.4		4.4	4.0		4.2		4.0	3.0		3.5	
RHC Specialty Approved															
Hilleshog 9739 (RHC)	4.9	5.0	5.0	4.9	4.9	4.2	4.1	4.2	4.1	4.1	3.6	2.3	4.3	3.0	3.4
Hilleshog 2219 (RHC)	4.8	4.8	5.0	4.8	4.9	4.2	3.9	4.1	4.1	4.1	3.5	2.6	4.1	3.1	3.4
CLS Specialty Approved															
Beta 9986 (CLS)	4.3	4.0		4.2		2.3	1.8		2.0		4.3	4.2		4.3	
Beta 9952 (CLS)	4.1	4.2		4.1		2.8	3.0		2.9		3.4	2.3		2.9	
Crystal M951	5.2	4.6		4.9		2.4	1.9		2.2		4.6	4.8		4.7	
Last Year of Sales															
Crystal M509	4.2	4.5	3.9	4.3	4.2	4.4	4.0	4.1	4.2	4.2	4.1	5.2	4.5	4.7	4.6
	Aphanomyces Ratings from SMBSC Nursery at Renville and Betaseed Nursery in Shakopee.					Cercospora Ratings from SMBSC Nursery in Renville and Betaseed Nursery near Randolph MN.					Rhizoctonia Ratings from SMBSC Nursery at Renville and BSDF Nursery in Michigan				
	Ratings are on scale of 1 - 9.					**Ratings are on scale of 1-9.**					**Ratings are on scale of 1 - 7.**				

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

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

SMBSC Agricultural Staff Variety Strip Trial - Summary

Strip Trial Means Table

Variety	Stand Count 28 DAP Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Acre	Percent of Mean Revenue per Acre
Beta 9780	183	16.8	89.8	30.7	8734.8	100.7%
Beta 9810	194	16.7	89.4	30.4	8475.8	97.6%
Beta 9986	207	16.3	90.1	33.6	9264.7	103.9%
Crystal M821	188	16.8	89.5	28.5	8057.8	93.1%
Crystal M837	201	16.8	89.6	29.1	8242.8	94.4%
Hilleshog 2327	202	16.5	89.7	32.8	9104.2	103.6%
SV 883	204	16.8	89.8	31.5	8899.1	104.82%
SV 894	200	16.7	89.7	31.4	8813.1	101.97%
Mean	197	16.7	89.7	31.0	8699.0	100.0
%CV	6	1.8	0.6	5.4	6.3	8.4
PR>F	0.0023	0.0181	0.2626	<0.0001	0.0005	0.0428
LSD (0.05)	12	0.3	0.5	1.7	548.3	8.4
Reps	8	8	8	8	8	8

Combined data from 8 locations with each location considered a replicate.
Locations: Renville, Hector, Redwood Falls, Willmar, Raymond, Maynard, Benson, and Bird Island.
Revenue is calculated using the 2019 crop payment calculator, utilizing values released Nov. 21, 2019

SMBSC Variety Strip Trial - Renville

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9780	195	17.7	90.9	27.9	300.5	8372	93.5%	Beta 9780
Beta 9810	183	17.6	90.7	29.5	298.8	8803	97.8%	Beta 9810
Beta 9986	208	17.3	91.3	33.7	295.9	9971	109.7%	Beta 9986
Crystal M821	198	18.2	91.2	25.2	311.5	7862	90.9%	Crystal M821
Crystal M837	183	17.9	91.0	26.1	303.9	7942	89.7%	Crystal M837
Hilleshog 2327	180	17.8	91.4	31.4	304.2	9557	108.0%	Hilleshog 2327
SV 883	196	18.1	91.2	27.7	309.0	8546	98.0%	SV 883
SV 894	216	18.2	91.5	31.0	312.3	9693	112.3%	SV 894
Crystal M579*	178	18.0	91.4	27.8	308.4	8561	98.1%	Crystal M579*
Average	**195**	**17.8**	**91.2**	**29.1**	**304.5**	**8843.2**	**100.0%**	**Average**

Planted: April 23, 2020
Harvested: September 30
Agriculturalist: Cody Bakker

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

SMBSC Variety Strip Trial - Hector

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9780	203.8	17.4	89.8	28.7	291.0	8345.9	96.7%	Beta 9780
Beta 9810	201.3	17.0	88.2	29.0	276.4	8002.3	87.6%	Beta 9810
Beta 9986	255.0	17.2	90.8	32.5	291.8	9488.0	110.2%	Beta 9986
Crystal M821	205.0	16.5	88.3	27.6	268.8	7410.5	78.4%	Crystal M821
Crystal M837	205.0	17.3	89.1	29.6	285.6	8461.3	96.1%	Crystal M837
Hilleshog 2327	218.8	17.5	89.5	35.1	291.4	10221.8	118.6%	Hilleshog 2327
SV 883	228.8	17.2	89.3	34.2	284.9	9751.3	110.4%	SV 883
SV 894	227.5	17.2	89.1	32.0	283.6	9061.8	102.1%	SV 894
SV 881*	218.8	16.8	89.1	33.1	277.6	9178.7	100.9%	SV 881*
Hilleshog 701*	216.3	17.1	90.0	30.2	286.4	8639.4	98.4%	Hilleshog 701*
Hilleshog 702*	220.0	16.3	88.3	31.3	265.2	8297.3	86.3%	Hilleshog 702*
Hilleshog 704*	221.3	17.3	88.9	33.1	285.3	9430.0	106.9%	Hilleshog 704*
Average	218.1	17.2	89.2	31.1	**284.2**	**8842.9**	**100.0%**	**Average**

Planted: April 21, 2020
Harvested: October 18, 2020
Agriculturalist - Pete Caspers

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

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 9780	171	15.7	88.7	33.2	256.3	8506.1	99.0%	Beta 9780
Beta 9810	175	16.1	87.8	31.5	259.9	8188.8	97.1%	Beta 9810
Beta 9986	193	15.5	88.4	36.0	252.6	9086.6	103.5%	Beta 9986
Crystal M821	158	16.1	87.6	31.7	258.1	8168.8	95.9%	Crystal M821
Crystal M837	186	16.1	88.1	30.4	260.3	7916.6	94.1%	Crystal M837
Hilleshog 2327	183	15.8	88.3	34.9	257.3	8976.6	105.0%	Hilleshog 2327
SV 883	179	15.9	87.7	34.6	255.4	8836.0	102.3%	SV 883
SV 894	168	15.8	88.4	34.5	256.3	8854.8	103.0%	SV 894
SV 863*	173	15.9	88.5	33.5	260.2	8727.9	103.6%	SV 863*
Average	**176**	**15.9**	**88.1**	**33.3**	**257.0**	**8566.8**	**100.0%**	**Average**

Planted: May 6, 2019
Harvested: October 15, 2019
Agriculturalist: Chris Dunsmore

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

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 9780	189	18.4	91.8	40.9	317.0	12963.8	104.9%	Beta 9780
Beta 9810	169	17.9	90.1	37.8	301.1	11383.8	87.8%	Beta 9810
Crystal M821	186	17.8	90.4	38.8	299.8	11618.4	89.3%	Crystal M821
Crystal M837	211	18.1	91.5	42.4	311.1	13176.8	104.9%	Crystal M837
Hilleshog 2327	193	18.3	91.7	41.1	315.6	12978.5	104.6%	Hilleshog 2327
SV 881	198	18.0	92.1	42.5	312.4	13263.0	106.0%	SV 881
SV 883	213	17.8	91.2	41.7	303.6	12664.1	98.5%	SV 883
SV 894	195	18.3	90.7	42.2	310.4	13088.0	104.0%	SV 894
Average	194	18.1	91.2	40.9	308.9	12642.0	100.0%	**Average**

Planted: April 23, 2020

Harvested: October 16, 2020

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 9780	169	16.5	90.0	26.4	276.2	7282.7	106.0%	Beta 9780
Beta 9810	191	17.1	90.7	23.7	289.6	6848.4	105.0%	Beta 9810
Beta 9986	203	16.2	89.9	21.5	269.6	5794.6	81.9%	Beta 9986
Crystal M821	196	17.1	90.5	23.4	289.2	6780.0	103.8%	Crystal M821
Crystal M837	199	16.3	89.9	21.0	271.2	5702.2	81.2%	Crystal M837
Hilleshog 2327	184	16.2	90.4	28.7	272.5	7809.8	111.8%	Hilleshog 2327
SV 883	205	16.9	90.5	25.7	285.6	7346.6	111.0%	SV 883
SV 894	204	16.5	90.4	24.5	277.2	6790.7	99.2%	SV 894
Average	194	16.6	90.3	24.4	278.9	6794.4	100.0%	**Average**

Planted: May 1, 2020

Harvested: September 29, 2020

Agriculturalist: Jared Kelm

***Strip trial was irrigated, and the data was used in the combined "Variety Strip Trial Means Table"

SMBSC Variety Strip Trial - Raymond

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9780	180	17.0	89.6	36.3	282.9	10274.2	109.5%	Beta 9780
Beta 9810	205	16.6	88.5	35.8	271.6	9709.7	98.6%	Beta 9810
Beta 9986	211	15.7	88.3	40.5	254.9	10326.0	96.6%	Beta 9986
Crystal M821	205	17.0	89.4	33.9	281.7	9544.0	101.2%	Crystal M821
Crystal M837	233	16.7	89.0	35.7	274.7	9814.8	101.1%	Crystal M837
Hilleshog 2327	233	15.7	89.1	36.1	258.4	9335.3	89.0%	Hilleshog 2327
SV 883	229	16.7	89.0	35.4	275.5	9750.0	100.8%	SV 883
SV 894	186	16.7	89.8	35.7	277.5	9903.6	103.2%	SV 894
Average	**210**	**16.5**	**89.1**	**36.2**	**272.1**	**9832.2**	**100.0%**	**Average**

Planted: April 23, 2020

Harvested: September 18, 2020

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 9780	204	18.0	90.6	40.1	305.7	12250.1	103.8%	Beta 9780
Beta 9810	211	18.1	90.7	37.4	307.7	11495.7	98.0%	Beta 9810
Beta 9986	213	17.6	90.6	43.6	298.1	13008.4	107.6%	Beta 9986
Crystal M821	209	18.3	91.0	36.5	311.7	11391.0	98.3%	Crystal M821
Crystal M837	216	18.4	91.1	39.5	313.8	12393.9	107.6%	Crystal M837
Hilleshog 2327	218	17.6	90.0	39.5	295.7	11667.5	95.7%	Hilleshog 2327
SV 883	201	18.1	90.8	37.4	307.5	11492.9	97.9%	SV 883
SV 894	210	17.5	89.5	38.5	292.1	11249.4	91.1%	SV 894
Crystal M977*	229	17.7	90.9	41.2	300.4	12381.9	103.2%	Crystal M977*
Crystal M579*	(-)	18.4	90.4	33.8	311.5	10525.6	90.8%	Crystal M579*
Average	**210**	**18.0**	**90.5**	**39.1**	**304.0**	**11868.6**	**100.0%**	**Average**

Planted: April 21, 2020
Harvested: September 29, 2020
Agriculturalist: Austin Neubauer

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

SMBSC Variety Strip Trial - Bird Island

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9780	171	14.4	87.6	17.1	230.4	3944.3	89.1%	Beta 9780
Beta 9810	205	14.1	87.5	20.9	225.4	4713.4	102.1%	Beta 9810
Beta 9986	199	14.0	90.0	20.8	231.4	4821.1	109.7%	Beta 9986
Crystal M821	179	14.3	87.7	17.4	228.8	3969.9	88.5%	Crystal M821
Crystal M837	200	14.3	88.0	17.7	230.0	4074.0	91.7%	Crystal M837
Hilleshog 2327	205	14.1	87.6	20.1	225.0	4513.7	97.5%	Hilleshog 2327
SV 883	211	14.7	88.7	20.5	239.1	4895.4	117.9%	SV 883
SV 894	199	14.5	88.3	19.0	234.5	4443.7	103.5%	SV 894
Beta 9475*	(-)	14.3	88.1	16.5	230.3	3794.1	85.6%	Beta 9475*
Crystal M977*	201	14.0	88.7	21.9	227.3	4970.1	109.4%	Crystal M977*
Average	**196**	**14.3**	**88.2**	**19.2**	**230.6**	**4422.0**	**100.0%**	**Average**

Planted: April 20, 2020
Harvested: August 19, 2020
Agriculturalist: Les Plumley

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

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 9780	173	17.6	91.4	36.1	301.7	10902.9	108.2%	Beta 9780
Beta 9810	179	16.9	90.9	35.2	285.7	10044.8	94.3%	Beta 9810
Beta 9986	176	17.1	91.5	39.8	292.2	11622.2	111.7%	Beta 9986
Crystal M821	155	16.9	90.5	32.7	285.5	9336.6	87.6%	Crystal M821
Crystal M837	190	17.5	90.7	32.6	296.1	9637.6	93.9%	Crystal M837
Hilleshog 2327	193	17.1	91.0	36.9	291.4	10751.8	103.0%	Hilleshog 2327
SV 883	185	16.9	91.2	36.7	288.2	10574.2	100.2%	SV 883
SV 894	189	17.3	90.8	35.9	292.9	10507.5	101.2%	SV 894
Average	**180**	**17.2**	**91.0**	**35.7**	**291.7**	**10422.2**	**100.0%**	**Average**

Planted: April 22, 2020
Harvested: October 4, 2020
Agriculturalist: Scott Thaden

SMBSC Variety Strip Trial - Clontarf**

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9780	175	15.3	89.1	31.2	250.7	7812.3	100.6%	Beta 9780
Beta 9810	174	16.0	88.3	28.7	259.6	7447.7	100.7%	Beta 9810
Crystal M821	140	15.8	88.7	27.5	259.0	7132.9	96.2%	Crystal M821
Crystal M837	203	15.3	88.7	30.6	249.3	7617.7	97.3%	Crystal M837
Hilleshog 2327	165	15.6	89.6	30.0	258.2	7732.3	103.8%	Hilleshog 2327
SV 811	183	15.9	89.9	28.5	264.4	7540.1	104.5%	SV 811
SV 883	141	15.8	89.7	28.2	262.4	7408.3	101.6%	SV 883
SV 894	150	15.8	89.5	26.8	261.2	6992.6	95.4%	SV 894
Average	**166**	**15.7**	**89.2**	**28.9**	**258.1**	**7460.5**	**100.0%**	**Average**

Planted: April 21, 2020

Harvested: September 9, 2020

Agriculturalist: Scott Thaden

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

2020 Hector OVT Results

Entry Name	Entry Name	Tons		Sugar		ES		EST		ESA		Emergence		Purity	
		Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean
1 A	BTS 9036	32.8	100.9	16.5	99.8	14.0	99.2	279.2	99.2	9151.8	100.1	75.7	96.4	91.1	99.5
2 B	SV RR863	32.7	100.4	16.9	102.2	14.5	103.4	290.8	103.4	9630.7	105.3	81.0	103.2	92.2	100.7
3 C	Baseline 6 Crystal RR265	31.7	97.3	16.1	97.4	13.5	95.8	269.5	95.8	8573.2	93.7	76.1	96.9	90.4	98.9
4 D	BTS 9810	31.9	98.0	16.8	101.9	14.3	101.4	285.3	101.4	9134.7	99.9	77.9	99.3	91.0	99.5
5 E	Crystal M837	32.0	98.3	16.8	101.6	14.3	101.5	285.6	101.5	9139.8	99.9	78.6	100.2	91.3	99.8
6 F	BTS 9088	32.1	98.6	17.3	105.2	15.0	106.5	299.8	106.5	9587.9	104.8	77.6	98.8	92.2	100.8
7 G	HIL2375	31.6	97.2	16.5	99.8	13.9	98.8	277.9	98.8	8824.9	96.5	80.5	102.5	90.8	99.3
8 H	BTS 9002	34.6	106.2	15.7	95.1	13.3	94.5	265.8	94.5	9158.7	100.2	81.8	104.2	91.2	99.7
9 I	Crystal M821	31.2	96.0	17.0	103.0	14.5	103.0	289.9	103.0	9049.1	99.0	76.5	97.4	91.3	99.9
10 J	SV 805	33.4	102.6	16.6	100.8	14.2	101.0	284.2	101.0	9484.7	103.7	77.2	98.3	91.7	100.2
11 K	SV RR862	34.4	105.6	16.5	100.0	14.1	100.3	282.0	100.2	9694.3	106.0	73.0	92.9	91.6	100.1
12 L	SV 894	34.3	105.3	16.3	98.7	13.9	99.0	278.5	99.0	9650.5	105.5	76.7	97.7	91.8	100.4
13 M	Filler #4	33.1	101.5	16.1	97.6	13.6	96.6	271.7	96.6	8981.4	98.2	72.5	92.3	90.8	99.2
14 N	BTS 9780	32.2	98.8	16.9	102.5	14.5	103.0	289.8	103.0	9312.0	101.8	75.5	96.2	91.7	100.3
15 O	SV 893	31.8	97.7	16.8	102.0	14.3	102.0	286.8	101.9	8786.3	96.1	80.1	102.0	91.4	99.9
16 P	HIL9739	31.9	98.1	16.0	96.8	13.6	96.9	272.6	96.9	8715.9	95.3	80.4	102.4	91.7	100.3
17 Q	HIL2327	33.8	103.8	16.4	99.7	14.1	100.4	282.4	100.4	9554.5	104.5	76.5	97.4	92.0	100.6
18 R	Filler #2	30.3	93.0	16.7	101.0	14.2	100.9	283.9	100.9	8447.9	92.4	69.9	89.0	91.3	99.8
19 S	Crystal M089	33.1	101.5	16.4	99.2	14.0	99.6	280.1	99.6	9076.6	99.3	84.4	107.4	91.8	100.4
20 T	BTS 9044	32.7	100.3	17.1	103.9	14.8	105.1	295.9	105.2	9697.2	106.0	80.8	102.9	92.2	100.8
21 U	Filler #3	31.3	96.1	17.1	103.5	14.5	102.7	289.0	102.7	8946.6	97.8	82.0	104.4	90.8	99.3
22 V	Crystal M509	36.1	110.9	16.1	97.6	13.6	96.9	272.8	97.0	9641.5	105.4	81.3	103.5	91.1	99.6
23 W	Crystal M028	32.3	99.2	16.8	102.2	14.4	102.5	288.4	102.5	9388.9	102.7	80.5	102.6	91.6	100.2
24 X	Crystal M977	33.8	103.7	16.6	100.5	14.4	102.2	287.6	102.2	9687.6	105.9	76.1	97.0	92.6	101.2
25 Y	BTS 9015	34.2	105.0	16.5	100.0	14.1	100.4	282.5	100.4	9664.5	105.7	76.6	97.6	91.7	100.3
26 Z	Baseline 10 Crystal M623	31.2	95.8	16.6	100.9	14.2	100.9	284.0	100.9	8822.3	96.5	82.4	105.0	91.5	100.0
27 AA	Crystal M002	33.2	101.9	16.3	98.7	13.9	98.8	278.0	98.8	9201.5	100.6	80.5	102.5	91.6	100.1
28 AB	HIL2378	33.0	101.5	16.2	98.4	13.7	97.6	274.8	97.7	9111.5	99.6	75.0	95.6	90.9	99.4
29 AC	Crystal M951	35.1	107.9	16.3	98.8	13.8	98.3	276.6	98.3	9745.5	106.6	84.9	108.1	91.2	99.7
30 AD	HIL2377	27.0	82.8	15.8	96.0	13.4	95.3	268.2	95.3	7239.1	79.2	82.9	105.6	91.1	99.6
31 AE	BTS 9986	34.7	106.4	16.1	97.5	13.7	97.3	273.8	97.3	9491.6	103.8	82.2	104.6	91.5	100.0
32 AF	BTS 9952	31.8	97.6	16.2	98.2	13.9	98.6	277.4	98.6	8783.4	96.0	75.5	96.2	91.9	100.5
33 AG	Filler #1	31.4	96.3	16.8	102.2	14.4	102.0	286.9	102.0	9010.6	98.5	73.3	93.3	91.3	99.8
34 AH	Baseline 7 Hilleshog 4017RR	31.8	97.6	16.2	98.2	13.8	98.3	276.6	98.3	8801.0	96.2	78.8	100.4	91.6	100.1
35 AI	HIL2219	31.0	95.2	16.9	102.3	14.4	102.6	288.8	102.7	8975.7	98.1	80.5	102.5	91.5	100.1
36 AJ	Crystal M055	31.6	97.0	16.0	97.2	13.6	96.5	271.6	96.5	8562.0	93.6	78.3	99.8	91.1	99.6
37 AK	HIL2379	34.3	105.3	16.7	101.5	14.4	102.2	287.6	102.2	9988.7	109.2	81.0	103.2	92.0	100.5
38 AL	Baseline 8 Hilleshog 9093RR	27.9	85.8	15.5	94.2	13.3	94.4	265.6	94.4	7552.8	82.6	77.5	98.7	91.9	100.5
39 AM	Baseline 11 Beta 9780	34.3	105.2	16.6	100.5	14.2	100.8	283.7	100.8	9734.2	106.4	78.5	99.9	91.7	100.2
40 AN	Crystal M071	34.5	105.9	16.9	102.4	14.6	103.7	291.8	103.7	10068.6	110.1	70.8	90.2	92.3	100.9
41 AO	Baseline 9 SV RR863	32.5	99.7	16.8	102.1	14.4	102.5	288.3	102.5	9472.7	103.6	77.5	98.8	91.7	100.2
42 AP	Crystal M015	33.4	102.4	16.5	99.9	14.0	99.5	280.0	99.5	9369.3	102.5	80.0	101.9	91.2	99.7
43 AQ	SV 806	27.6	84.6	15.9	96.6	13.5	95.8	269.4	95.7	7285.8	79.7	80.3	102.2	91.0	99.4
44 AR	SV 807	31.2	96.0	16.6	100.7	14.1	100.0	281.2	100.0	8570.6	93.7	78.4	99.8	90.9	99.4
45 AS	BTS 9935	32.1	98.6	17.1	103.6	14.6	103.6	291.5	103.6	9377.3	102.5	80.2	102.2	91.4	99.9
46 AT	SV 883	34.4	105.6	16.8	102.0	14.4	102.7	288.8	102.7	9948.3	108.8	82.1	104.5	91.9	100.4
47 AU	HIL2376	33.9	104.1	16.0	97.3	13.7	97.4	274.1	97.4	9035.8	98.8	80.4	102.4	91.7	100.2
48 AV	SV 881	33.0	101.5	16.4	99.7	14.0	99.6	280.2	99.6	9231.4	100.9	81.2	103.5	91.5	100.0
49 AW	BTS 9023	35.5	109.1	16.3	98.9	13.8	97.9	275.5	97.9	9739.3	106.5	75.7	96.5	90.9	99.3
GRAND MEAN		32.6		16.5		14.1		281.4		9144.9		78.5		91.5	
CV		6.0		2.5		3.1		3.1		6.7		7.9		0.9	
Error d.f.		203		181		181		181		180		204		217	
LSD		2.2		0.5		0.5		9.9		697.3		7.1		0.9	
Alpha level		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
Max. Mean		36.1		17.3		15.0		299.8		10068.6		84.9		92.6	
Max. Plot		39.7		18.1		15.8		315.8		11414.6		97.2		94.8	
Min. Mean		27.0		15.5		13.3		265.6		7239.1		69.9		90.4	
Min. Plot		20.5		14.4		12.1		242.0		5315.7		54.2		88.1	
No. of Reps		6		6		6		6		6		6		6	
Rep-Msqr		78.7		0.3		0.2		73.0		6030701.1		106.3		0.9	
Residual		3.5		0.2		0.2		70.9		342682.0		37.7		0.7	
RE-RCBD		119.6		104.4		103.7		103.6		116.5		100.6		100.0	

2020 Lake Lillian OVT Results

		Tons		Sugar		ES		EST		ESA		Emergence		Purity	
Entry Name	Entry Name	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean
1 A	BTS 9036	35.8	106.0	16.4	98.3	13.7	98.0	274.3	97.9	9827.3	103.9	74.5	103.3	90.3	99.8
2 B	SV RR863	33.4	98.8	16.4	98.6	13.9	99.3	278.0	99.3	9369.9	99.1	74.3	103.0	90.9	100.5
3 C	Baseline 6 Crystal RR265	31.6	93.4	16.1	96.9	13.4	95.5	267.4	95.5	8473.3	89.6	70.6	97.9	89.6	99.0
4 D	BTS 9810	33.5	99.1	16.3	97.9	13.6	97.0	271.7	97.0	9141.6	96.7	74.9	103.9	89.9	99.4
5 E	Crystal M837	34.1	100.8	17.1	102.9	14.5	103.3	289.3	103.3	9856.2	104.2	76.1	105.5	90.6	100.2
6 F	BTS 9088	32.6	96.6	17.6	105.8	14.9	106.7	298.8	106.7	9777.5	103.4	78.9	109.5	90.9	100.4
7 G	HIL2375	30.7	90.8	16.3	98.2	13.6	97.3	272.6	97.3	8384.7	88.7	64.9	89.9	89.9	99.4
8 H	BTS 9002	37.6	111.1	15.8	94.8	13.2	94.3	264.2	94.3	9923.2	104.9	71.7	99.4	90.4	99.9
9 I	Crystal M821	32.8	97.0	16.7	100.3	14.1	100.7	282.0	100.7	9049.5	95.7	72.0	99.8	90.7	100.2
10 J	SV 805	33.6	99.4	16.9	101.7	14.3	101.9	285.4	101.9	9481.6	100.2	76.5	106.1	90.6	100.1
11 K	SV RR862	34.5	102.1	16.8	100.8	14.3	101.8	285.0	101.8	9839.6	104.0	69.6	96.5	91.1	100.7
12 L	SV 894	34.4	101.8	16.7	100.1	14.0	100.3	280.9	100.3	9663.2	102.2	73.3	101.7	90.6	100.2
13 M	Filler #4	33.3	98.5	16.6	99.9	13.9	99.4	278.4	99.4	9273.4	98.0	71.5	99.2	90.2	99.6
14 N	BTS 9780	33.6	99.3	17.1	102.7	14.1	100.9	282.7	100.9	9560.6	101.1	65.9	91.4	89.2	98.6
15 O	SV 893	33.9	100.3	16.8	100.8	14.2	101.3	283.8	101.4	9603.7	101.5	78.4	108.7	90.8	100.4
16 P	HIL9739	34.0	100.7	16.3	98.3	13.8	98.3	275.3	98.3	9370.2	99.1	64.2	89.0	90.6	100.1
17 Q	HIL2327	34.5	102.1	16.8	101.3	14.3	102.4	286.7	102.4	9919.9	104.9	70.6	98.0	91.2	100.8
18 R	Filler #2	32.1	95.0	16.5	99.2	13.7	97.5	273.0	97.5	8718.8	92.2	66.8	92.7	89.3	98.7
19 S	Crystal M089	37.6	111.3	16.4	98.5	13.8	98.7	276.3	98.7	10410.4	110.1	76.5	106.1	90.6	100.2
20 T	BTS 9044	32.2	95.2	17.4	104.5	14.6	103.9	291.0	103.9	9390.0	99.3	70.2	97.3	89.9	99.4
21 U	Filler #3	31.4	93.0	17.0	102.1	14.3	102.0	285.6	102.0	8981.3	95.0	69.1	95.9	90.3	99.8
22 V	Crystal M509	39.8	117.8	15.8	94.9	13.2	94.3	264.1	94.3	10518.2	111.2	75.4	104.6	90.3	99.8
23 W	Crystal M028	34.6	102.3	17.2	103.3	14.7	105.3	294.9	105.3	10168.9	107.5	75.2	104.3	91.7	101.4
24 X	Crystal M977	38.0	112.3	16.3	98.0	13.9	99.1	277.7	99.1	10530.4	111.3	75.6	104.8	91.4	101.1
25 Y	BTS 9015	36.6	108.3	16.9	101.3	14.4	102.9	288.3	102.9	10541.9	111.5	75.9	105.3	91.5	101.2
26 Z	Baseline 10 Crystal M623	32.9	97.4	16.6	99.6	13.9	99.2	277.9	99.2	9156.5	96.8	66.1	91.6	90.3	99.8
27 AA	Crystal M002	35.4	104.7	16.9	101.8	14.3	101.8	285.2	101.8	10082.3	106.6	76.7	106.3	90.4	100.0
28 AB	HIL2378	34.2	101.1	16.9	101.6	14.3	102.4	286.8	102.4	9796.7	103.6	72.6	100.7	90.9	100.5
29 AC	Crystal M951	37.9	112.2	16.0	96.4	13.4	95.6	267.6	95.6	10141.1	107.2	71.4	99.0	90.1	99.5
30 AD	HIL2377	28.5	84.4	16.5	99.4	13.8	98.6	276.1	98.6	7868.7	83.2	70.0	97.1	89.9	99.4
31 AE	BTS 9986	36.8	108.8	16.0	96.4	13.5	96.3	269.6	96.3	9897.5	104.6	73.3	101.7	90.5	100.1
32 AF	BTS 9952	34.2	101.3	16.2	97.3	13.7	98.0	274.5	98.0	9399.7	99.4	72.9	101.2	91.0	100.6
33 AG	Filler #1	33.4	98.8	16.6	99.7	13.9	99.4	278.3	99.4	9122.2	96.4	63.6	88.3	90.2	99.7
34 AH	Baseline 7 Hilleshog 4017RR	33.9	100.2	16.9	101.4	14.1	100.5	281.4	100.5	9586.1	101.4	73.3	101.6	89.8	99.3
35 AI	HIL2219	31.9	94.2	17.4	104.8	14.8	105.7	296.0	105.7	9413.7	99.5	63.3	87.7	90.8	100.4
36 AJ	Crystal M055	33.8	99.9	16.0	96.4	13.5	96.3	269.8	96.3	9112.7	96.3	69.9	96.9	90.6	100.2
37 AK	HIL2379	34.1	100.9	16.4	98.9	13.8	98.5	276.0	98.5	9414.8	99.5	66.6	92.3	90.3	99.8
38 AL	Baseline 8 Hilleshog 9093RR	30.5	90.1	16.7	100.6	14.0	99.8	279.4	99.8	8505.4	89.9	78.0	108.2	89.9	99.4
39 AM	Baseline 11 Beta 9780	33.9	100.2	17.0	102.1	14.3	102.0	285.7	102.0	9688.1	102.4	74.3	103.0	90.3	99.8
40 AN	Crystal M071	31.4	92.8	16.9	101.6	14.3	102.2	286.2	102.2	9066.4	95.9	71.9	99.7	90.8	100.3
41 AO	Baseline 9 SV RR863	34.2	101.3	16.7	100.5	14.2	101.1	283.1	101.1	9679.7	102.3	74.3	103.0	90.9	100.4
42 AP	Crystal M015	36.2	107.1	16.3	98.2	13.8	98.4	275.6	98.4	9981.6	105.5	72.5	100.6	90.7	100.2
43 AQ	SV 806	28.0	82.9	16.7	100.6	14.0	100.2	280.7	100.2	7840.2	82.9	80.6	111.8	90.2	99.7
44 AR	SV 807	30.3	89.6	16.6	99.6	13.9	99.3	278.2	99.3	8464.2	89.5	73.7	102.3	90.3	99.8
45 AS	BTS 9935	32.6	96.3	17.3	103.9	14.6	104.1	291.5	104.1	9479.5	100.2	72.1	99.9	90.5	100.0
46 AT	SV 883	33.2	98.1	16.8	101.0	14.1	100.6	281.8	100.6	9372.6	99.1	79.1	109.7	90.1	99.6
47 AU	HIL2376	36.1	106.8	16.0	95.9	13.3	95.3	266.8	95.3	9639.6	101.9	64.9	90.0	90.2	99.7
48 AV	SV 881	32.5	96.0	16.7	100.3	14.2	101.3	283.6	101.3	9193.1	97.2	65.6	90.9	91.2	100.8
49 AW	BTS 9023	34.4	101.9	16.8	101.1	14.2	101.2	283.4	101.2	9775.7	103.4	73.9	102.6	90.5	100.1
GRAND MEAN		33.8		16.6		14.0		280.0		9458.2		72.1		90.5	
CV		6.3		2.6		3.5		3.6		7.8		12.1		1.1	
Error d.f.		203		188		188		188		188		203		188	
LSD		2.4		0.5		0.6		11.3		841.9		9.9		1.1	
Alpha level		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
Max. Mean		39.8		17.6		14.9		298.8		10541.9		80.6		91.7	
Max. Plot		40.9		18.1		15.6		311.1		11555.2		91.7		93.9	
Min. Mean		28.0		15.8		13.2		264.1		7840.2		63.3		89.2	
Min. Plot		17.5		14.8		12.4		247.0		4452.9		33.3		85.0	
No. of Reps		6		6		6		6		6		6		6	
Rep-Msqr		16.8		1.5		1.9		752.0		3010403.8		471.7		2.9	
Residual		4.2		0.2		0.2		93.9		515903.6		72.1		1.0	
RE-RCBD		105.2		102.8		102.8		102.8		104.3		102.5		101.7	

2020 Murdock OVT Results

		Tons		Sugar		ES		EST		ESA		Emergence		Purity	
Entry Name	Entry Name	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean	Mean	% mean
1 A	BTS 9036	38.9	100.9	15.5	98.1	12.9	98.8	257.9	98.8	10058.8	99.9	75.4	100.4	89.7	100.6
2 B	SV RR863	38.6	100.0	15.9	100.1	13.1	100.4	262.0	100.4	10092.5	100.2	82.3	109.5	89.5	100.3
3 C	Baseline 6 Crystal RR265	37.0	96.0	15.3	96.5	12.4	95.3	248.7	95.3	9218.3	91.5	71.6	95.2	88.4	99.1
4 D	BTS 9810	39.6	102.6	16.1	101.5	13.3	101.6	265.2	101.6	10471.1	104.0	75.0	99.7	89.2	100.0
5 E	Crystal M837	39.4	102.1	16.3	102.7	13.4	102.3	266.9	102.3	10514.0	104.4	77.0	102.5	88.8	99.6
6 F	BTS 9088	39.0	101.2	16.5	104.1	13.6	104.3	272.3	104.3	10642.8	105.7	71.8	95.5	89.1	99.9
7 G	HIL2375	37.3	96.7	15.7	99.1	12.7	97.6	254.7	97.6	9448.9	93.8	73.8	98.2	88.3	99.1
8 H	BTS 9002	40.9	106.1	15.3	96.3	12.3	94.3	246.0	94.3	10076.2	100.0	73.9	98.4	87.9	98.5
9 I	Crystal M821	37.4	96.9	16.0	101.1	13.0	99.4	259.4	99.4	9686.1	96.2	76.2	101.4	88.2	98.9
10 J	SV 805	37.2	96.4	15.8	99.9	13.1	100.7	262.8	100.7	9755.5	96.9	71.9	95.7	89.7	100.6
11 K	SV RR862	38.7	100.4	15.8	99.5	13.2	101.2	264.1	101.2	10207.3	101.3	77.9	103.7	90.5	101.4
12 L	SV 894	38.7	100.3	15.6	98.6	13.0	99.4	259.3	99.4	9945.7	98.7	79.7	106.0	89.8	100.7
13 M	Filler #4	35.9	93.2	16.1	101.4	13.1	100.6	262.6	100.6	9437.0	93.7	74.8	99.5	88.7	99.4
14 N	BTS 9780	38.6	100.0	16.5	104.3	13.8	105.5	275.2	105.5	10459.2	103.8	73.0	97.2	89.8	100.7
15 O	SV 893	38.2	99.1	15.6	98.4	12.7	97.1	253.3	97.1	9684.6	96.2	76.4	101.6	88.5	99.2
16 P	HIL9739	35.2	91.2	15.5	97.8	12.6	96.5	251.7	96.5	8841.6	87.8	72.6	96.7	88.4	99.2
17 Q	HIL2327	39.1	101.4	15.9	100.3	13.3	101.6	265.0	101.6	10395.7	103.2	73.7	98.0	90.0	100.9
18 R	Filler #2	37.1	96.3	15.7	99.1	12.9	98.9	258.0	98.9	9608.3	95.4	77.4	103.0	89.2	100.0
19 S	Crystal M089	43.3	112.2	15.9	100.5	13.1	100.5	262.1	100.5	11413.3	113.3	73.2	97.4	89.1	99.9
20 T	BTS 9044	39.9	103.5	16.8	105.8	14.1	107.8	281.3	107.8	11153.2	110.7	82.4	109.6	90.1	101.1
21 U	Filler #3	39.5	102.3	16.5	104.0	13.8	105.7	275.8	105.7	10887.4	108.1	74.4	99.0	90.0	101.0
22 V	Crystal M509	45.9	119.0	15.1	95.5	12.3	94.0	245.2	94.0	11173.5	110.9	74.5	99.2	88.5	99.2
23 W	Crystal M028	40.1	104.1	16.6	104.8	13.9	106.3	277.5	106.3	11127.2	110.5	74.1	98.6	90.0	100.9
24 X	Crystal M977	41.9	108.5	15.7	99.3	13.1	100.2	261.6	100.2	10940.4	108.6	73.7	98.1	89.9	100.8
25 Y	BTS 9015	40.3	104.5	16.0	100.9	13.0	99.5	259.6	99.5	10374.4	103.0	73.0	97.1	88.4	99.1
26 Z	Baseline 10 Crystal M623	36.7	95.2	15.8	99.4	13.2	101.4	264.5	101.4	9681.5	96.1	77.4	102.9	90.5	101.4
27 AA	Crystal M002	41.0	106.3	16.1	101.8	13.5	103.5	269.9	103.5	11051.0	109.7	76.7	102.1	90.1	101.0
28 AB	HIL2378	39.2	101.6	15.1	95.5	12.5	95.5	249.3	95.6	9701.3	96.3	74.9	99.7	89.4	100.2
29 AC	Crystal M951	42.6	110.5	15.6	98.5	12.8	98.4	256.7	98.4	11131.3	110.5	70.8	94.2	89.1	99.9
30 AD	HIL2377	32.2	83.5	15.9	100.1	12.9	98.7	257.5	98.7	8287.4	82.3	79.9	106.3	88.3	99.0
31 AE	BTS 9986	40.9	105.9	15.7	99.1	13.0	99.4	259.5	99.4	10801.3	107.2	83.1	110.5	89.4	100.3
32 AF	BTS 9952	37.7	97.8	15.0	94.9	12.2	93.5	244.1	93.6	9210.4	91.4	74.6	99.2	88.5	99.2
33 AG	Filler #1	37.4	97.1	15.5	98.0	12.6	96.9	252.9	96.9	9527.7	94.6	68.1	90.7	88.5	99.3
34 AH	Baseline 7 Hilleshog 4017RR	37.2	96.5	15.5	97.6	12.6	96.5	251.8	96.5	9367.0	93.0	72.0	95.8	88.7	99.4
35 AI	HIL2219	37.3	96.7	16.7	105.4	13.9	106.1	276.9	106.1	10309.4	102.4	76.0	101.1	89.5	100.3
36 AJ	Crystal M055	34.9	90.4	15.2	95.7	12.2	93.7	244.6	93.8	8539.4	84.8	67.8	90.2	88.0	98.6
37 AK	HIL2379	38.9	100.8	15.9	100.4	13.2	101.0	263.6	101.0	10233.8	101.6	79.1	105.2	89.6	100.5
38 AL	Baseline 8 Hilleshog 9093RR	35.0	90.7	14.9	93.8	12.0	91.7	239.2	91.7	8520.2	84.6	73.5	97.8	87.9	98.5
39 AM	Baseline 11 Beta 9780	40.6	105.2	16.6	104.7	13.9	106.5	277.9	106.5	11311.5	112.3	78.1	104.0	90.1	101.0
40 AN	Crystal M071	40.9	106.1	16.4	103.2	13.7	104.6	272.9	104.6	11129.5	110.5	65.0	86.5	90.0	101.0
41 AO	Baseline 9 SV RR863	38.1	98.8	15.8	99.5	13.1	100.0	261.0	100.0	9952.7	98.8	79.3	105.5	89.5	100.3
42 AP	Crystal M015	39.4	102.1	15.6	98.5	12.9	98.6	257.4	98.6	10146.6	100.7	72.0	95.8	89.3	100.1
43 AQ	SV 806	32.5	84.4	15.7	99.0	12.7	97.1	253.5	97.2	8297.4	82.4	73.7	98.1	87.9	98.6
44 AR	SV 807	35.3	91.5	15.8	99.5	13.1	100.2	261.3	100.2	9293.5	92.3	74.8	99.6	89.5	100.4
45 AS	BTS 9935	37.5	97.3	16.8	106.0	13.8	106.0	276.7	106.0	10443.8	103.7	80.1	106.6	89.0	99.8
46 AT	SV 883	38.1	98.8	15.8	100.0	13.1	100.4	262.1	100.4	10064.5	99.9	81.0	107.8	89.5	100.3
47 AU	HIL2376	38.6	100.0	15.6	98.4	12.7	97.4	254.2	97.4	9712.1	96.4	70.5	93.8	88.6	99.3
48 AV	SV 881	37.8	97.9	15.8	100.0	13.2	101.0	263.6	101.0	9900.9	98.3	79.5	105.8	89.9	100.8
49 AW	BTS 9023	42.5	110.1	16.1	101.4	13.3	102.2	266.6	102.2	11297.3	112.2	74.8	99.5	89.7	100.6
GRAND MEAN		38.6		15.8		13.1		260.9		10071.9		75.2		89.2	
CV		3.9		2.8		4.0		4.0		5.1		8.0		1.3	
Error d.f.		204		184		184		184		184		204		184	
LSD		1.7		0.5		0.6		11.9		586.8		6.9		1.3	
Alpha level		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
Max. Mean		45.9		16.8		14.1		281.3		11413.3		83.1		90.5	
Max. Plot		47.2		17.4		14.7		293.1		12570.5		91.7		93.4	
Min. Mean		32.2		14.9		12.0		239.2		8287.4		65.0		87.9	
Min. Plot		30.3		14.2		10.9		217		7567.78		51.4		84.4	
No. of Reps		6		6		6		6		6		6		6	
Rep-Msqr		15.3		2.5		3.6		1424.7		4861255.3		308.6		7.8	
Residual		2.16		0.17		0.25		99.6		238474		32.8		1.3	
RE-RCBD		105.5		121.6		119.1		119.1		134.4		122.5		102.5	

2020 Wood Lake OVT Results

Entry	Name	Entry Name	Tons Mean	Tons % mean	Sugar Mean	Sugar % mean	ES Mean	ES % mean	EST Mean	EST % mean	ESA Mean	ESA % mean	Emergence Mean	Emergence % mean	Purity Mean	Purity % mean
1	A	BTS 9036	35.2	99.6	17.4	98.1	14.5	98.1	289.1	98.0	10197.4	98.0	77.6	98.8	89.4	100.1
2	B	SV RR863	37.6	106.5	17.9	101.0	14.9	101.1	298.1	101.1	11225.2	107.9	80.8	102.9	89.4	100.0
3	C	Baseline 6 Crystal RR265	32.1	90.8	17.9	101.0	15.0	101.5	299.3	101.5	9605.1	92.3	75.5	96.1	89.7	100.3
4	D	BTS 9810	35.1	99.5	18.2	102.4	15.2	102.8	303.1	102.8	10564.6	101.5	79.9	101.7	89.6	100.3
5	E	Crystal M837	34.9	98.7	18.0	101.4	15.0	101.5	299.2	101.5	10384.2	99.8	78.4	99.8	89.4	100.0
6	F	BTS 9088	34.5	97.5	18.6	104.8	15.6	106.0	312.8	106.1	10838.8	104.2	81.7	104.1	90.1	100.8
7	G	HIL2375	33.2	94.0	17.8	100.2	14.8	100.5	296.3	100.5	9842.6	94.6	77.3	98.4	89.6	100.2
8	H	BTS 9002	35.3	99.8	17.3	97.5	14.4	97.4	287.1	97.4	10084.4	96.9	81.9	104.3	89.4	100.0
9	I	Crystal M821	34.1	96.5	18.2	102.5	15.2	103.1	304.2	103.2	10338.9	99.4	78.8	100.3	89.7	100.4
10	J	SV 805	36.7	104.0	17.7	99.6	14.7	99.4	293.2	99.4	10766.8	103.5	75.4	96.0	89.3	99.9
11	K	SV RR862	37.9	107.4	17.7	100.0	14.7	99.8	294.3	99.8	11211.4	107.7	77.5	98.6	89.3	99.9
12	L	SV 894	37.6	106.3	17.4	98.1	14.4	97.9	288.7	97.9	10873.4	104.5	79.1	100.6	89.3	99.9
13	M	Filler #4	36.7	103.8	17.9	100.7	14.9	100.9	297.5	100.9	10903.9	104.8	76.8	97.8	89.5	100.1
14	N	BTS 9780	37.3	105.6	18.0	101.6	14.9	101.2	298.3	101.2	11085.7	106.5	77.5	98.6	89.1	99.7
15	O	SV 893	37.0	104.7	17.4	98.2	14.4	98.0	288.8	98.0	10688.0	102.7	72.5	92.3	89.3	99.9
16	P	HIL9739	34.1	96.6	17.9	100.7	14.8	100.6	296.7	100.6	10062.7	96.7	78.9	100.4	89.3	99.9
17	Q	HIL2327	36.7	104.0	17.7	99.7	14.7	99.8	294.4	99.8	10763.4	103.4	79.9	101.7	89.5	100.1
18	R	Filler #2	35.3	99.9	18.0	101.4	14.9	100.9	297.4	100.9	10491.5	100.8	78.3	99.7	89.0	99.6
19	S	Crystal M089	35.0	99.0	17.3	97.7	14.3	97.1	286.4	97.1	9967.0	95.8	82.6	105.2	89.1	99.7
20	T	BTS 9044	33.7	95.3	18.5	104.4	15.5	105.3	310.5	105.3	10395.5	99.9	84.7	107.9	89.9	100.5
21	U	Filler #3	34.4	97.2	17.9	101.1	15.0	101.8	300.1	101.8	10276.1	98.7	71.7	91.2	89.8	100.4
22	V	Crystal M509	41.5	117.4	16.9	95.5	14.0	95.0	280.0	95.0	11612.1	111.6	82.1	104.5	89.2	99.8
23	W	Crystal M028	35.1	99.3	18.3	102.9	15.3	103.7	305.9	103.7	10723.5	103.0	76.5	97.3	89.8	100.5
24	X	Crystal M977	38.0	107.5	17.3	97.6	14.4	97.4	287.0	97.3	10899.8	104.7	83.6	106.4	89.3	99.9
25	Y	BTS 9015	36.7	103.9	18.2	102.9	15.2	103.2	304.3	103.2	11098.2	106.6	81.4	103.6	89.5	100.1
26	Z	Baseline 10 Crystal M623	32.3	91.5	18.0	101.3	14.9	101.2	298.5	101.2	9616.3	92.4	78.1	99.4	89.3	99.9
27	AA	Crystal M002	37.4	105.7	17.7	99.5	14.6	99.0	291.8	99.0	10955.9	105.3	87.4	111.3	89.0	99.6
28	AB	HIL2378	34.2	96.8	17.4	98.3	14.4	97.8	288.5	97.9	9862.9	94.8	81.6	103.9	89.1	99.7
29	AC	Crystal M951	38.9	110.2	17.2	97.1	14.2	96.6	284.8	96.6	11065.3	106.3	79.6	101.4	89.1	99.7
30	AD	HIL2377	32.2	91.1	17.1	96.4	14.1	95.9	282.7	95.9	9139.6	87.8	79.2	100.9	89.1	99.7
31	AE	BTS 9986	36.9	104.4	17.4	98.0	14.3	97.2	286.6	97.2	10600.4	101.9	85.5	108.8	89.0	99.5
32	AF	BTS 9952	34.8	98.4	17.9	100.7	15.0	102.0	300.7	102.0	10487.3	100.8	75.0	95.4	90.2	100.9
33	AG	Filler #1	32.9	93.1	18.4	103.8	15.4	104.5	308.0	104.4	10127.2	97.3	75.6	96.3	89.7	100.3
34	AH	Baseline 7 Hilleshog 4017RR	33.1	93.8	17.6	99.5	14.7	99.4	293.2	99.4	9728.2	93.5	76.6	97.5	89.4	100.0
35	AI	HIL2219	29.6	83.7	18.1	102.3	15.1	102.2	301.2	102.2	8867.7	85.2	72.6	92.4	89.2	99.8
36	AJ	Crystal M055	33.7	95.3	17.8	100.1	14.9	101.0	297.7	101.0	10064.9	96.7	79.1	100.7	89.9	100.6
37	AK	HIL2379	35.6	100.8	17.6	99.5	14.6	99.3	292.6	99.2	10401.5	100.0	83.7	106.6	89.3	99.9
38	AL	Baseline 8 Hilleshog 9093RR	30.6	86.5	17.4	98.3	14.5	98.0	288.9	98.0	8842.2	85.0	82.1	104.5	89.2	99.8
39	AM	Baseline 11 Beta 9780	34.4	97.3	18.0	101.5	15.0	101.6	299.6	101.6	10268.2	98.7	80.3	102.2	89.4	100.1
40	AN	Crystal M071	37.9	107.4	17.8	100.5	14.9	100.7	297.0	100.7	11259.5	108.2	67.7	86.1	89.5	100.1
41	AO	Baseline 9 SV RR863	36.3	102.8	17.4	97.9	14.3	97.1	286.4	97.1	10421.4	100.1	79.1	100.7	88.9	99.5
42	AP	Crystal M015	37.2	105.4	18.0	101.3	14.9	101.2	298.5	101.2	11112.6	106.8	77.5	98.6	89.3	99.9
43	AQ	SV 806	32.8	92.8	17.3	97.8	14.3	97.1	286.2	97.1	9364.2	90.0	79.5	101.3	89.0	99.6
44	AR	SV 807	35.2	99.7	17.3	97.7	14.3	97.0	285.9	97.0	10044.9	96.5	82.5	105.0	89.0	99.5
45	AS	BTS 9935	33.5	94.7	18.1	102.0	15.0	101.7	299.9	101.7	10033.5	96.4	77.4	98.5	89.1	99.7
46	AT	SV 883	35.9	101.6	17.4	97.9	14.4	97.8	288.5	97.8	10336.4	99.3	82.3	104.8	89.4	100.1
47	AU	HIL2376	36.2	102.5	17.5	98.6	14.5	98.3	289.8	98.3	10555.2	101.4	63.9	81.3	89.3	99.9
48	AV	SV 881	37.5	106.1	17.8	100.4	14.8	100.3	295.6	100.3	11126.5	106.9	78.1	99.4	89.3	99.9
49	AW	BTS 9023	36.8	104.1	17.5	98.8	14.6	99.3	292.9	99.3	10727.3	103.1	74.6	95.0	89.8	100.5
	GRAND MEAN		35.3		17.7		14.7		294.9		10406.3		78.6		89.4	
	CV		6.9		2.4		3.0		3.0		7.2		10.5		0.7	
	Error d.f.		197		198		198		198		194		202		198	
	LSD		2.8		0.5		0.5		10.2		855.1		9.4		0.8	
	Alpha level		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
	Max. Mean		41.5		18.6		15.6		312.8		11612.1		87.4		90.2	
	Max. Plot		46.6		19.4		16.5		328.9		13134.6		97.2		91.7	
	Min. Mean		29.6		16.9		14.0		280.0		8842.2		63.9		88.9	
	Min. Plot		26.6		16.1		13.1		262.8		7922.8		31.9		87.0	
	No. of Reps		6		6		6		6		6		6		6	
	Rep-Msqr		84.5		0.7		0.8		312.2		4739289.3		493.2		3.1	
	Residual		5.4		0.2		0.2		75.1		513467.0		64.2		0.4	
	RE-RCBD		133.8		106.9		106.7		106.8		118.1		105.2		103.8	

Date of Harvest Trials
Lake Lillian, Hector, and Wood Lake, MN - 2020

Cody Groen

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.

Objectives: In 2011, SMBSC began to perform trials to measure the rate of growth of the sugar beets during the period from mid-August through early-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 of a portion of their sugar beet crop.

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 2020, the three Date of Harvest Trials were conducted at a location near Wood Lake, 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 accurately 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 August 13, 2020. Harvesting continued on a weekly basis until October 15, 2020. Harvest was conducted once a week, although intervals of exactly 7 days were unachievable due to weather. A total of twelve harvest timings were completed in 2020. Trials sites saw even stands and canopy development, minimal root rot, and CLS managed well. The Lake Lillian trial site was damaged by an early-July hail storm. It is possible that this event negatively influenced rate of gain for that site.

Table 1 shows the average pounds extractable sugar per acre (ESA) increase per day for each of the past ten years, between mid-August to early-October. From 2011-2019, the daily average rate of increase in ESA was 80.3 pounds extractable sugar per day. The increase in ESA per day for 2020 of 79.0 pounds was similar to the long term mean rate of gain. 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 0.4% per week. In 2020, sugar increased at a rate slightly above the long term average at 0.07% per day and approximately 0.47% per week. This is slightly increased from the ten year average. That said, 2018 saw an unprecedentedly low rate of gain which influences the long-term average. When 2018 is removed, the long term rate of gain is closer to 0.07% sugar per day. Figure 2 illustrates the data from 2020 for sugar percent rate of gain.

Table 3 shows the average rate of gain of tons per acre for the ten year period of 2011-2020. The long-term average is 0.21 tons per acre gained per day, and approximately 1.49 tons per week. The 2020 rate of gain for TPA continues to show a relatively linear rate of gain as in prior years, but the rate of gain was considerably slowed, at 0.16 TPA per day and 1.12 TPA per week, about 75% the long-term rate of gain. Figure 3 illustrates the data collected in 2020. This reduction may be influenced by early-July hail damage that occurred on one of the three sites tested in 2020 and the subsequent reduction in growth rate it created on that site.

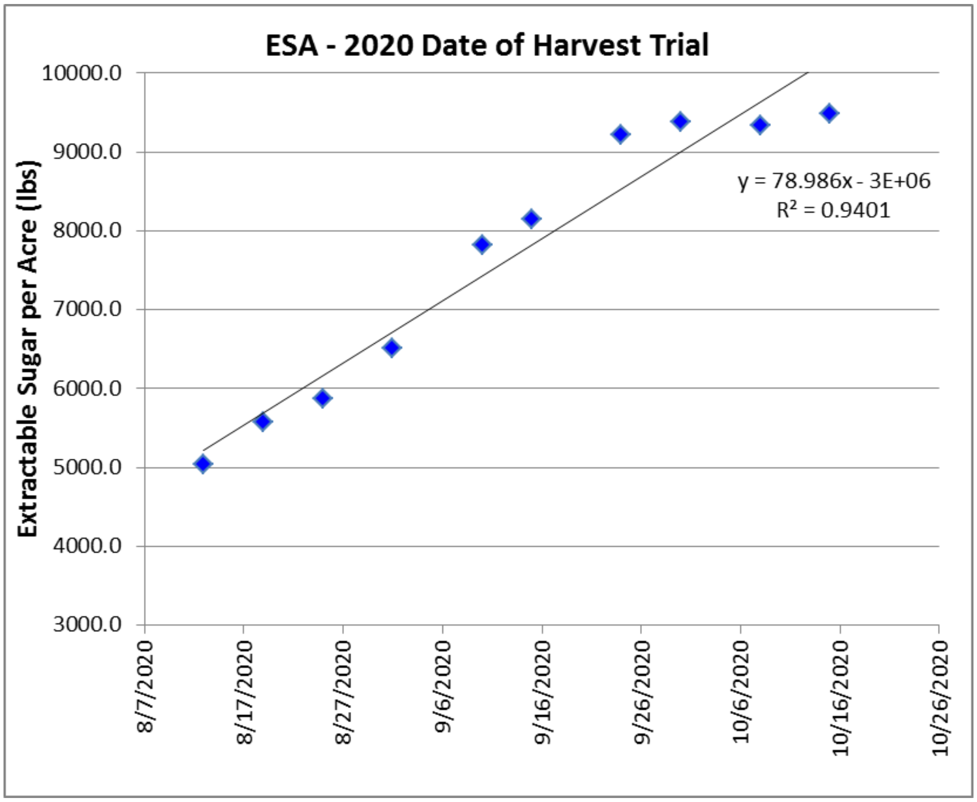

Figure 1. Extractable sugar per acre (ESA) data collected during the 2020 Date of Harvest trials, plotted across the harvest period, depicting a general positive trend.

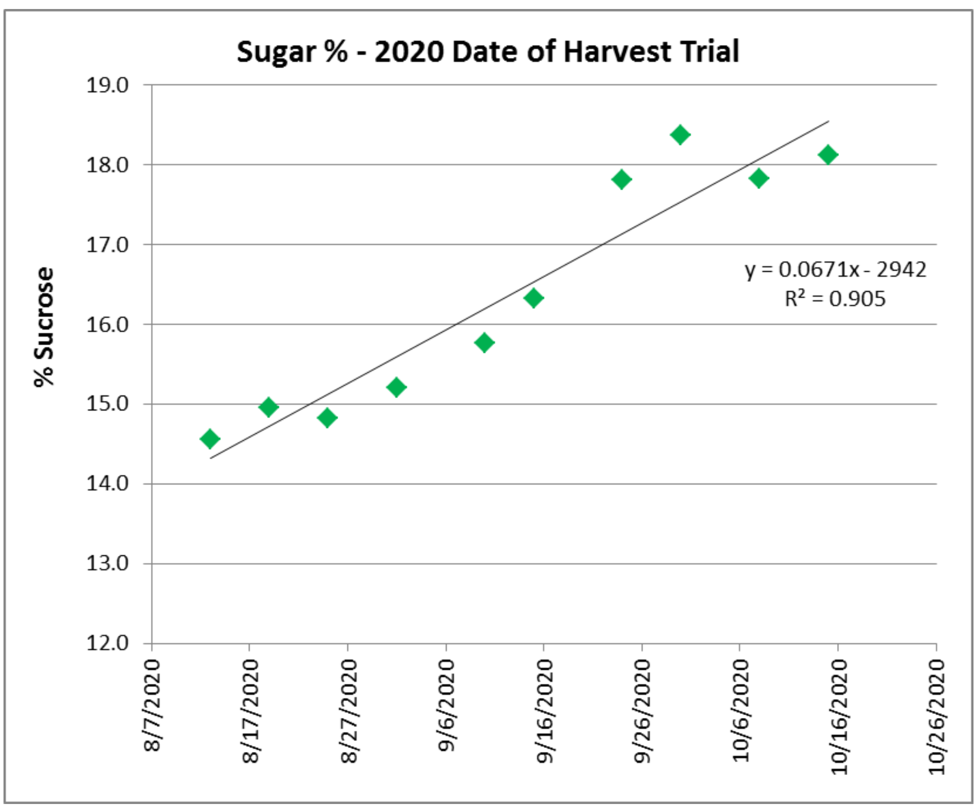

Figure 2. Sugar percent data collected during the 2020 Date of Harvest Trials, plotted across the harvest period, depicting a general positive trend.

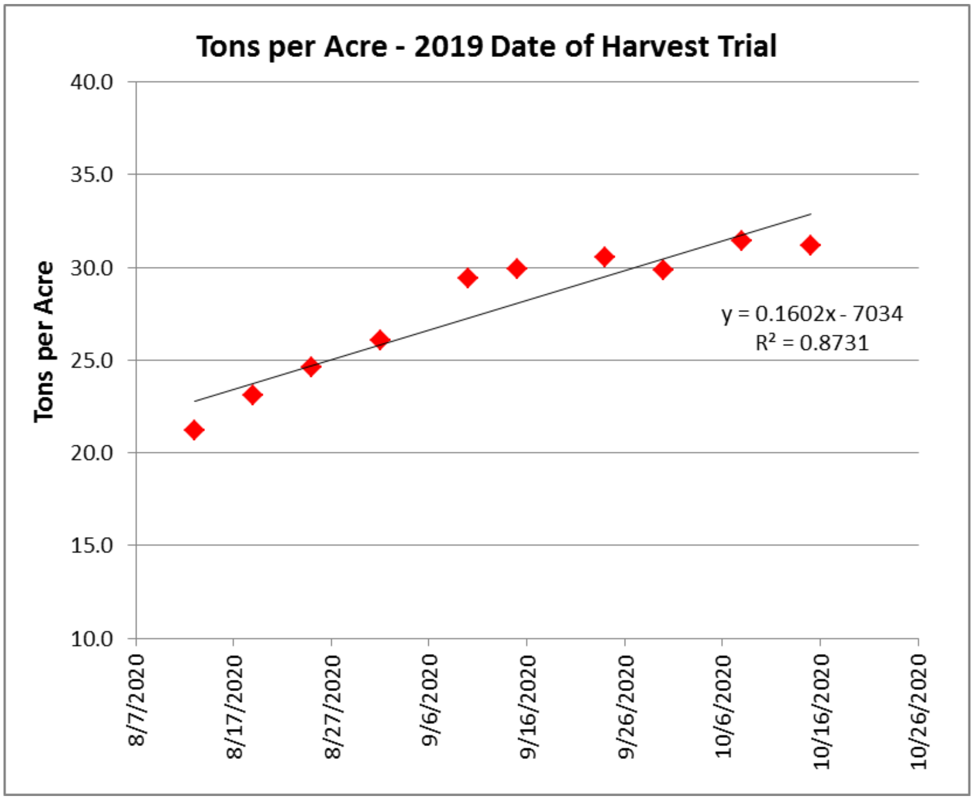

Figure 3. Tons per acre data collected during the 2020 Date of Harvest Trials, plotted across the harvest period, depicting a general positive trend.

Table 1.

2011-2020 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
Average (2011-2019)	80.3
2020	79.0

Table 2.

2011-2020 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
Average (2011-2018)	0.06	0.40
2020	0.07	0.47

Table 3.

2011-2020 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
Average (2011-2019)	0.21	1.49
2020	0.16	1.12

Cercospora Leafspot Early Detection Project

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Introduction: Cercospora leafspot is the most destructive foliar disease of sugar beets in the SMBSC growing area. Cercospora leafspot 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 leafspot 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 years fields and attempt to detect the DNA of *C. beticola* in these leaf samples. This detection will be accomplished 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 8, SMBSC Agriculturists collected leaf samples from three sugar beet fields in their district that were planted on a common line to a 2019 sugar beet field. These same fields were sampled on a weekly basis until July 9. In addition to these fields, two research sites were also sampled each week. 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 five week period. Each field sample consisted of three leaves. This provided three analyses per field per week. The leaf samples were delivered each week to SMBSC research personnel for analysis. Samples were generally taken on Tuesday and Wednesday of each week and stored in a refrigerator until Thursday or Friday when the analysis was performed. 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. A leaf punch sample was obtained from each of the three leaves in every field sample and the appropriate dilutions were made to prepare the samples for qPCR analysis. 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.

Results and Discussion:

Analysis of samples began on June 10 and June 11 for the samples taken earlier that week. In addition to the field samples, a sugar beet and CLS control sample were added to each analysis as check samples. These check samples provided confidence that the qPCR procedure operated correctly and provided values to compare against the field sample values generated by the analysis. Low level cercospora positive results were seen on a few samples in the first week. When these samples were re-run to confirm the results, these analyses were negative. This was the first year of this type of analysis, and thus there was uncertainty about the results from the first three analyses until additional data could be generated. However, on June 19 one field sample produced a value that provided confidence the analysis was detecting cercospora DNA in the sample. The results of this analysis can be seen in Figure 1. Figure 1 is the graphical representation of the June 19 analysis 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. The lines near the bottom of the graph represent samples that did not detect cercospora DNA in the analysis.

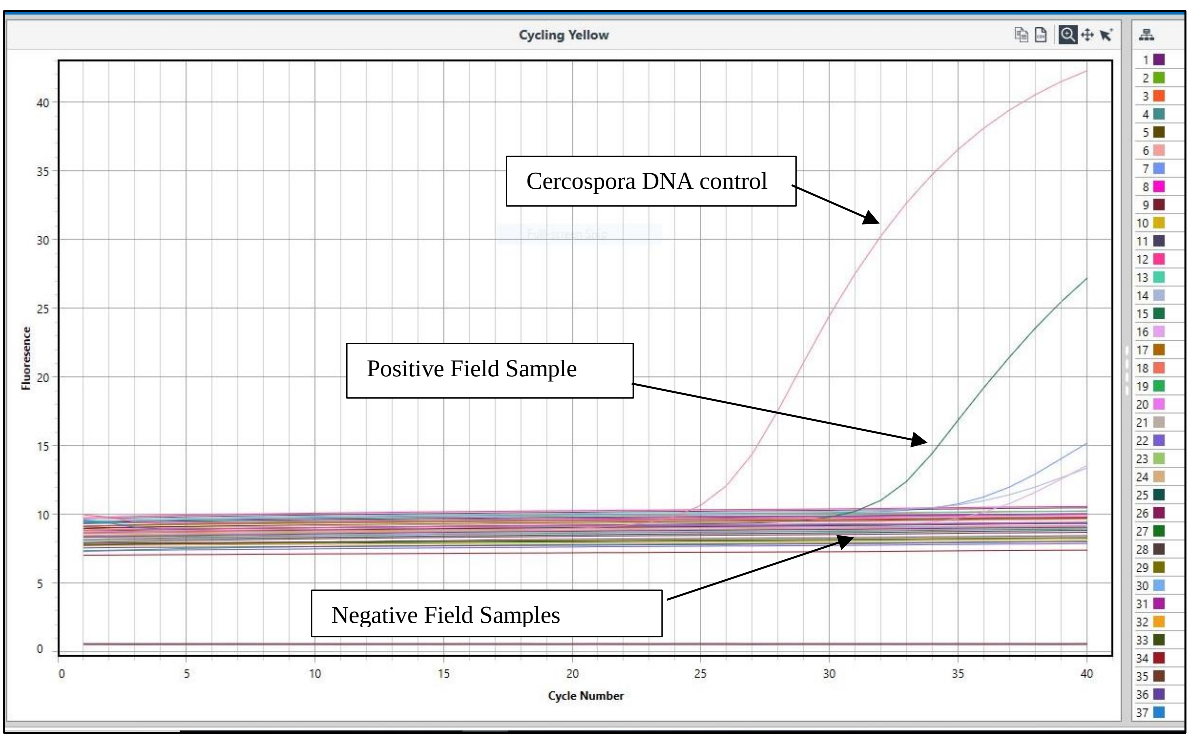

Figure 1. Graphical representation of Mic qPCR analysis of June 19 leaf samples.

Cercospora leafspot was visually confirmed in the field with the positive qPCR detection approximately one week following the qPCR detection. Table 2 summarizes the results of the qPCR analyses during the five week period. The detections increased over the five week period and then leveled out over the final three weeks. This points out the importance of the leaf sampling protocol in the fields. The leaf samples for this project were targeted to common lines to 2019 sugar beet fields. Cercospora DNA was detected in many of the samples, however it will not be found in all leaves within a given area of a field. The sampling technique of obtaining random leaves from each field area may contribute to the leveling out of the percentage of detections.

Date	Cercospora Detections by Leaf Sample	Percent of Samples with Detection
June 10-11, 2020	8 of 80 samples	10%
June 18-19, 2020	9 of 80 samples	11.3%
June 25-26, 2020	30 of 92 samples	32.6%
July 1-2, 2020	27 of 78 samples	34.6%
July 8-9, 2020	20 of 68 samples	29.4%

Table 2. Cercospora detections by qPCR analysis.

Conclusions:

The first year of this project has increased our knowledge of the equipment operation, sampling protocols, and interpretation of the data. Cercospora can be detected in field samples using this technology prior to the development of leafspot symptoms. This can provide an early alarm to the infection of the sugar beet crop by this fungal disease. The date of first detection may be different from season to season based on the environmental conditions of the year. Additional years of testing will be needed to determine if the detection of cercospora DNA is consistent by calendar date or if environmental conditions and planting dates can modify this detection date.

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 this 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 2019. The beets were defoliated in the fall of 2019, 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 that there were ample levels of inoculum on the soil surface. Four methods for reducing inoculum were tested in this trial using small plots 6 rows wide and 10 feet long (Table 1). Treatment 1 was the untreated check. Treatment 2 used Oxidate 2.0 (peroxyacetic acid) applied 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. Treatment 5 used propane to burn the residue and potentially destroy the overwintering spores. After treatments were applied to the trial area, Crystal RR018 was planted at a high population (109,000 seeds/acre) without any additional tillage 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 10 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 ratings are reported for each date (Table 2).

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

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

Results and Discussion: The application of heat/burning of residue and the use of tillage to bury the inoculum delayed the onset of CLS disease development in the 2020 trial (Table 2 and Figure 1). The heat/burn treatment was statistically lower than the untreated check and the tilling treatment was numerically lower than the untreated check. The Oxidate 2.0 and Badge SC treatments did not appear to impact the onset of disease in the 2020 trial. These results are similar to the results from the 2019 Inoculum Reduction Trial. The differences between the treatments would likely be more pronounced if tested across larger areas. In small plots the treatment effects only last for a short period of time before adjacent treatments impact the level of disease. A third year of testing is planned to verify the results of the 2019 and 2020 trials. A site has been established to continue this trial in 2021 to obtain a third year of data.

	Date of Rating						
Treatment	**10-Jul**	**13-Jul**	**15-Jul**	**17-Jul**	**20-Jul**	**22-Jul**	**Ave.**
Untreated	2.5	3.8	4.5	5.3	5.1	6.2	4.6
Oxidate 2.0	2.9	3.7	4.5	5.5	5.5	6.4	4.8
Tilled	2.1	2.9	3.5	4.6	4.4	5.5	3.8
Badge SC	3.3	4.2	5.1	5.6	6.0	6.6	5.2
Heat	1.9	2.4	3.2	4.2	4.3	5.2	3.6
Mean	2.6	3.4	4.2	5.1	5.1	6.0	4.4
CV	25.2	20.8	17.9	13.2	12.6	11.5	14.7
Pr>F	0.051	0.022	0.020	0.036	0.010	0.063	0.022
lsd (0.05)	NS	1.1	1.2	1.0	1.0	NS	1.0

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

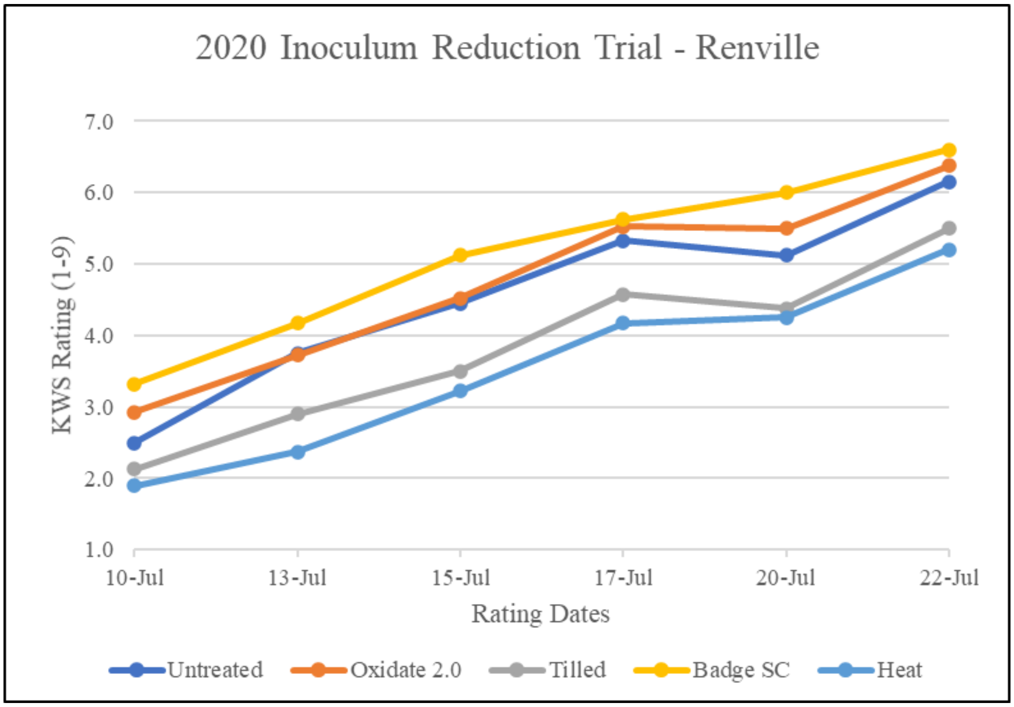

Figure 1: Foliar ratings using KWS (1-9) scale. Ratings are an average of all raters for each date.

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: Separate trials were conducted as randomized complete block with four replications at the same site near Clara City, MN. These trials evaluated fungicides in a program setting, but also for individual efficacy. These trials will be referred to as, the Program and Fungicide Screening trials, respectively. This site was planted on April 27th using Crystal 018 with 3gpa of 6-24-6 starter fertilizer applied in-furrow. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 1.67 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 6th. Six fungicide applications were made in the Fungicide Screening Trial and in the Program Trial beginning July 9th and continuing on a ten to twelve-day spray interval. Applications were made using a custom-made tractor sprayer traveling 3.6mph 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 CO2 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 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 25th 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 tare lab. The data was analyzed for significance using SAS version 9.4. The analysis for the Program Trial only utilized reps 2 through 4 due to water damage to rep 1 which caused stand loss and inconsistent disease and yield in that rep.

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 of the other treatments. The remainder of the treatments were fairly similar with regard to yield and had yield and quality parameters comparable to the cooperative average. More significant differences were observed in the visual foliar ratings (Table 2). The untreated check had a much higher rating throughout the season than all of the other treatments. The Standard Program with no tank-mix partners had a significantly higher rating than all other treatments with the exception of the untreated check. In general, the Standard Programs, which included two copper tank-mix applications, had a slightly higher rating than the EBDC Programs, which contained no copper products. There were not many differences in the Program Trial between treatments that included different adjuvants.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	15.2 a	21.0 a	12.6 a	251.0 a	4953.0 a	89.8 a
Standard Program	17.1 bcd	28.0 b	14.5 cd	289.0 cde	8128.3 bcd	90.7 cd
Standard Inverse Program	16.6 b	29.1 bc	13.8 b	277.3 bc	8082.3 bcd	90.1 ab
No Tank-Mix Program	16.4 b	27.1 b	13.8 b	275.0 b	7448.0 b	90.3 abc
Standard Inverse w/ Lucento	17.0 bcd	28.6 bc	14.4 bc	289.0 cde	8259.0 bcde	91.1 de
Standard Inverse w/ Provysol	17.1 bcd	26.4 b	14.5 cd	289.3 cde	7635.7 bc	90.9 de
EBDC Program No Adj.	17.3 cd	32.3 c	14.7 cd	294.3 de	9491.3 e	90.9 de
EBDC Program w/ Masterlock	17.4 cd	29.0 bc	14.8 cd	295.7 de	8607.7 bcde	91.1 de
EBDC Program w/ Masterlock & Transfix	17.3 cd	27.4 b	14.7 cd	293.0 de	8023.7 bcd	91.0 de
EBDC Program w/ Reguard & Diligence	17.4 cd	30.0 bc	14.8 cd	295.0 de	8882.0 cde	90.9 de
EBDC Program w/ Reguard, Diligence, & Ndemand	17.7 d	30.4 bc	15.1 d	301.5 e	9040.0 de	91.3 e
EBDC Program w/ Justified & Cohere	16.9 bc	28.0 b	14.3 bc	285.3 bcd	8021.0 bcd	90.6 bcd
EBDC Program w/ Cerium Elite	17.4 cd	32.3 c	14.8 cd	295.7 de	9545.0 e	90.7 cd
EBDC Program w/ Liberate	17.4 cd	26.5 b	14.7 cd	294.3 de	7792.7 bcd	90.8 cde
Standard Inverse Program w/ Early Topguard	17.4 cd	27.3 b	14.7 cd	295.0 de	8045.7 bcd	90.8 cde
Standard Inverse Program w/ Early Manzate	17.1 bcd	29.9 bc	14.5 cd	290.0 cde	8639.3 bcde	90.6 bcd
Mean	17.1	28.3	14.4	288.5	8198.0	90.7
CV%	2.5	8.6	2.8	2.8	10.1	0.4
Pr>F	0.0006	0.0012	0.0004	0.0003	0.0025	0.0131
lsd (0.05)	0.70	4.00	0.68	13.39	1362.5	0.59

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	29-Jul	7-Aug	17-Aug	26-Aug	4-Sep	14-Sep	23-Sep
Check	3.5 a	5.8 a	6.8 a	9.0 a	9.0 a	9.0 a	9.0 a
Standard Program	1.3 c	2.5 c	2.7 c	4.5 c	5.8 c	6.1 c	6.7 c
Standard Inverse Program	1.3 c	2.2 cd	2.4 cde	4.3 cd	5.2 cd	5.6 def	6.3 cdefgh
No Tank-Mix Program	1.8 b	3.2 b	4.0 b	6.3 b	7.3 b	7.9 b	8.4 b
Standard Inverse w/ Lucento	1.3 c	2.1 d	2.5 cde	4.1 cde	5.1 d	5.9 cd	6.6 cd
Standard Inverse w/ Provysol	1.2 c	2.1 cd	2.5 cde	4.2 cde	5.1 d	5.7 de	6.5 cde
EBDC Program No Adj.	1.4 bc	2.1 d	2.2 cde	3.7 defg	4.6 defg	5.4 efgh	6.1 efghi
EBDC Program w/ Masterlock	1.2 c	2.1 cd	2.6 cd	3.7 defg	4.6 def	5.5 def	6.2 defgh
EBDC Program w/ Masterlock & Transfix	1.3 c	2.2 cd	2.5 cde	3.7 defg	4.8 de	5.4 efg	6.4 cdef
EBDC Program w/ Reguard & Diligence	1.3 c	2.0 d	2.3 cde	3.5 fg	4.4 efg	4.9 i	5.8 ghi
EBDC Program w/ Reguard, Diligence, & Ndemand	1.3 c	1.8 d	2.0 e	3.2 g	4.1 fg	5.0 hi	5.6 i
EBDC Program w/ Justified & Cohere	1.2 c	2.1 cd	2.3 cde	3.6 efg	4.7 def	5.1 ghi	5.9 fghi
EBDC Program w/ Cerium Elite	1.1 c	1.8 d	2.1 de	3.2 g	3.9 g	5.0 hi	5.8 hi
EBDC Program w/ Liberate	1.2 c	2.1 d	2.2 cde	3.9 def	4.8 de	5.3 efgh	6.4 cdef
Standard Inverse Program w/ Early Topguard	1.1 c	1.9 d	2.4 cde	3.9 def	4.8 de	5.5 def	6.4 cdef
Standard Inverse Program w/ Early Manzate	1.2 c	1.9 d	2.1 de	3.7 defg	4.7 def	5.3 fghi	6.3 cdefg
Mean	1.4	2.4	2.7	4.3	5.2	5.8	6.5
CV%	19.4	10.2	11.5	8.5	7.4	4.0	4.8
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.40	0.40	0.52	0.61	0.64	0.38	0.52

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 or Proline with a copper product treatment had either significantly or numerically lower extractable sugar per acre (ESA) than almost all other treatments with two modes-of-action. Manzate Prostick and Proline applied as a tank-mix treatment had significantly higher ESA than either product applied alone. The difference in the foliar ratings correlated well with the differences seen in the yield parameters (Table 4). The untreated check had the highest foliar rating followed by treatments with only one mode-of-action and the Proline with a copper product treatments. Most of the other treatments with two modes-of-action were very similar with the exception of the Proline + Manzate Prostick tank mix having a significantly lower rating.

Conclusion: The results of the Program Trial and 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 no clear benefit to using an adjuvant with CLS fungicide applications in terms of disease control or ESA. The use of copper or SDHI products did not appear to add any significant benefit to disease control. These results would indicate that EBDC products are the most effective class of fungicides currently available to control CLS in sugar beets and that Proline is the most effective triazole product. These results are consistent with trials conducted 2019.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	14.8 a	23.5 a	12.3 a	245.3 a	5761.9 a	89.8 NS
Manzate Prostick	17.0 bc	31.7 bcdef	14.4 bcd	287.9 bcd	9127.4 cdef	90.8 NS
Proline	17.1 bc	30.8 bcd	14.4 bcd	287.3 bcd	8828.6 bc	90.4 NS
Manzate Prostick & Proline	17.4 d	33.7 fg	14.8 e	296.1 e	9964.4 g	90.9 NS
Manzate Prostick & Lucento	17.3 cd	33.4 efg	14.7 de	294.5 de	9823.9 fg	91.0 NS
Manzate Prostick & Topguard	17.3 cd	34.2 g	14.7 de	293.9 de	10035.1 g	90.8 NS
Manzate Prostick and Eminent VP	17.3 cd	32.6 cdefg	14.7 de	294.1 de	9588.0 defg	91.2 NS
Manzate Prostick and Inspire XT	17.5 d	32.8 defg	14.8 e	295.3 e	9690.0 efg	90.6 NS
Manzate Prostick and Tin	17.0 bc	33.3 efg	14.4 bcd	287.4 bcd	9667.2 defg	90.6 NS
Proline & Badge SC	16.8 b	29.4 b	14.2 b	283.5 b	8341.8 b	90.5 NS
Proline & Champ 2 Flowable	17.0 bc	31.1 bcde	14.4 bcd	287.5 bcd	8934.6 bcd	90.7 NS
Proline & Agrilife Copper	17.0 bc	30.4 bc	14.4 bcd	287.7 bcd	8757.4 bc	90.7 NS
Manzate Prostick & Provysol (5oz)	17.0 bc	31.7 bcdef	14.3 bc	286.3 bc	9069.3 bcde	90.4 NS
Manzate Prostick & Provysol (4oz)	17.1 bcd	33.2 efg	14.5 bcde	289.5 bcde	9620.0 defg	90.6 NS
Manzate Prostick & Enable 2F	17.2 cd	33.1 defg	14.6 cde	292.3 cde	9670.0 defg	90.8 NS
Proline & Oxidate 5.0	17.3 cd	32.2 cdefg	14.7 cde	293.7 de	9447.5 cdefg	91.1 NS
Manzate Prostick & Eminent VP (6.5oz) + Topguard (7oz)	17.3 cd	33.8 fg	14.6 cde	291.7 cde	9847.7 fg	90.5 NS
Manzate Prostick & Eminent VP (25oz)	17.2 cd	33.0 defg	14.5 bcde	290.7 bcde	9589.3 defg	90.5 NS
Mean	17.0	31.9	14.4	288.1	9202.7	90.7
CV%	1.5	5.2	1.8	1.8	5.7	0.5
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.1323
lsd (0.05)	0.36	2.32	0.37	7.37	745.4	NS

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

Treatment	29-Jul	7-Aug	17-Aug	26-Aug	4-Sep	14-Sep	23-Sep
Check	4.8 a	6.2 a	7.3 a	9.0 a	9.0 a	9.0 a	9.0 a
Manzate Prostick	1.8 b	3.2 b	3.6 c	5.9 b	6.6 b	7.1 b	7.9 b
Proline	1.3 d	2.5 de	3.2 cd	5.5 b	6.4 b	7.2 b	7.9 b
Manzate Prostick & Proline	1.2 d	1.6 h	1.9 h	2.5 h	3.3 j	3.6 g	4.4 g
Manzate Prostick & Lucento	1.2 d	2.0 fgh	2.3 efg	4.2 ef	5.2 ghi	6.2 ef	6.8 f
Manzate Prostick & Topguard	1.3 d	2.1 efg	2.5 efg	4.5 de	5.4 fgh	6.5 de	7.2 de
Manzate Prostick and Eminent VP	1.4 cd	2.3 ef	2.7 e	4.8 d	5.9 cde	6.7 cd	7.4 cd
Manzate Prostick and Inspire XT	1.2 d	1.9 gh	2.1 fgh	4.0 gf	5.0 hi	6.0 f	6.7 f
Manzate Prostick and Tin	1.7 bc	2.8 cd	2.7 e	4.9 d	5.6 efg	6.5 de	7.0 ef
Proline & Badge SC	1.9 b	3.1 bc	4.1 b	5.5 b	6.4 b	7.1 b	7.9 b
Proline & Champ 2 Flowable	1.9 b	3.3 b	4.0 b	5.4 bc	6.2 bcd	7.0 bc	7.8 b
Proline & Agrilife Copper	1.9 b	3.3 b	4.1 b	5.8 b	6.4 bc	7.2 b	7.9 b
Manzate Prostick & Provysol (5oz)	1.3 d	2.3 efg	2.5 efg	4.6 de	5.4 efgh	6.4 e	6.9 ef
Manzate Prostick & Provysol (4oz)	1.3 d	2.0 fgh	2.6 e	4.6 de	5.5 efg	6.3 ef	6.9 ef
Manzate Prostick & Enable 2F	1.3 d	2.4 ef	2.5 ef	4.9 cd	5.7 efg	6.5 de	7.0 ef
Proline & Oxidate 5.0	1.2 d	2.0 fgh	2.8 de	4.6 de	5.7 edf	6.5 de	7.5 c
Manzate Prostick & Eminent VP (6.5oz) + Topguard (7oz)	1.2 d	2.0 fg	2.4 efg	4.3 ef	5.4 fghi	6.3 ef	7.0 ef
Manzate Prostick & Eminent VP (25oz)	1.2 d	1.9 gh	2.1 gh	3.5 gf	4.9 i	6.0 f	6.7 f
Mean	1.6	2.6	3.1	4.9	5.8	6.6	7.2
CV%	12.5	10.8	9.8	7.3	6.3	3.3	3.0
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.30	0.40	0.43	0.51	0.52	0.30	0.30

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.

Program Trial		Rate/Acre	Application Code
1) Check	Untreated	n/a	ABCDEF
2) Standard Program	SuperTin	8 oz	ACE
	Masterlock	6.4 oz	ABCDEF
	Inspire XT	7 oz	B
	Badge SC	32 oz	CF
	Manzate Prostick	2 lbs	ABDE
	Proline	5.7 oz	F
	Eminent VP	13 oz	D
3) Standard Inverse Program	Inspire XT	7 oz	A
	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Manzate Prostick	2 lbs	ABDE
	Proline	5.7 oz	E
	Masterlock	6.4 oz	ABCDEF
4) Standard No Tank-Mix Program	SuperTin	8 oz	ACE
	Inspire XT	7 oz	B
	Eminent VP	13 oz	D
	Proline	5.7 oz	F
	Masterlock	6.4 oz	ABCDEF
5) Standard Inverse Program	Lucento	5.5 oz	A
w/ Lucento	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Manzate Prostick	2 lbs	ABDE
	Proline	5.7 oz	E
	Masterlock	6.4 oz	ABCDEF
6) Standard Inverse Program	Provysol	5 oz	A
w/ Provysol	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Manzate Prostick	2 lbs	ABDE
	Proline	5.7 oz	E
	Masterlock	6.4 oz	ABCDEF
7) EBDC Program	Inspire XT	7 oz	A
	Manzate Prostick	2 lbs	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Induce	0.125 %	E
	Proline	5.7 oz	E
8) EBDC Program	Inspire XT	7 oz	A
w/ Masterlock	Manzate Prostick	2 lbs	ABCDEF
	Masterlock	6.4 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
9) EBDC Program	Inspire XT	7 oz	A
w/ Masterlock and Transfix	Manzate Prostick	2 lbs	ABCDEF
	Masterlock	6.4 oz	ABCDEF
	Transfix	4 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E

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

Program Trial Continued		Rate/Acre	Application Code
10) EBDC Program	Inspire XT	7 oz	A
w/ Reguard and Diligence	Manzate Prostick	2 lbs	ABCDEF
	Reguard	12 oz	ABCDEF
	Diligence	1.5 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
11) EBDC Program	Inspire XT	7 oz	A
w/ Reguard, Diligence, and Ndemand	Manzate Prostick	2 lbs	ABCDEF
	Reguard	12 oz	ABCDEF
	Diligence	1.5 oz	ABCDEF
	N-Demand	1 gal	ACE
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
12) EBDC Program	Inspire XT	7 oz	A
w/ Justified and Cohere	Manzate Prostick	2 lbs	ABCDEF
	Justified	3 oz	ABCDEF
	Cohere	0.125 %	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
13) EBDC Program	Inspire XT	7 oz	A
w/ Cerium Elite	Manzate Prostick	2 lbs	ABCDEF
	Cerium Elite	6.4 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
14) EBDC Program	Inspire XT	7 oz	A
w/ Liberate	Manzate Prostick	2 lbs	ABCDEF
	Liberate	12.8 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
15) Standard Inverse Program	Inspire XT	7 oz	A
w/ Early Topguard	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Manzate Prostick	2 lbs	ABDE
	Proline	5.7 oz	E
	Masterlock	6.4 oz	0ABCDEF
	Topguard	14 oz	0
16) Standard Inverse Program	Inspire XT	7 oz	A
w/ Early Manzate Prostick	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Manzate Prostick	2 lbs	0ABDE
	Proline	5.7 oz	E
	Masterlock	6.4 oz	0ABCDEF

CLS x Fertility 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. 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 optimizing the performance of the fungicides currently available.

Objective: Trials need to be conducted to test the efficacy of fungicide programs and determine if there are any other practices that could improve the performance of fungicides that are currently available. Plant health can impact the severity of some diseases and pests. A plant that is lacking nutrients or is otherwise stressed may be more susceptible to infection. This trial evaluated the impact of fertilizers and plant health products on the severity of CLS in sugar beets.

Materials and Methods: This was conducted as randomized complete block with four replications near Hector, MN. This site was planted on May 5th using Crystal 018 and 3 gpa 6-24-6 applied as an infurrow starter for all treatments except 9, 10, 11, 12, and 13. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 1.5 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 10th. Six fungicide applications were made beginning July 16th and continuing on a ten to twelve-day spray interval (Table 3). Applications were made using a custom-made tractor sprayer traveling 3.6mph 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 CO2 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 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 October 9th 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 tare lab. The data was analyzed for significance using SAS version 9.4.

Results: This trial site received several large rain events during the growing season that led to saturated soil conditions and a reduced crop yield for the entire site. Due to the lengthy and complex treatments, results will be discussed by treatment number. For full treatment details refer to Table 3. Treatment 13 had a higher extractable sugar per acre (ESA) compared to most other treatments, but not significantly higher that treatments 3, 8, 11, and 19. The treatments that had the higher ESA were treatments with foliar fertilizer products or a higher soil applied nitrogen rate. This may be the results of the large rain events and potential loss of fertilizer to leaching and denitrification. There were not many large differences in the CLS foliar ratings other than the check. The rest of the treatments were within 1 CLS rating point with some of the treatments with foliar fertilizers having the highest ratings.

Conclusion: The purpose of this trial was to identify a new practice or product that would improve CLS control via plant health. There appeared to be a negative trend in the disease control when some foliar fertilizers were applied. The opposite trend occurred in the ESA with the foliar fertilizer products having a slightly higher yield. The results of this trial do not support any practice or product to help improve the control of CLS. However, the results do suggest some level of caution when applying additional products in the fungicide applications. These results also show, in one year of data, that additional nitrogen may improve overall yield when fields are subject to difficult growing conditions such as saturated soils.

Trt #	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	14.4 a	19.5	11.6 a	233.0 a	4547.0 a	88.3
2	16.2 cde	22.6	13.3 cdef	266.3 cdefg	6019.0 bcde	89.0
3	16.3 e	25.2	13.6 f	271.3 g	6841.3 ef	89.6
4	16.2 cde	20.9	13.2 bcdef	263.7 bcdefg	5518.3 b	88.6
5	16.3 e	22.8	13.4 def	267.5 efg	6085.7 bcde	88.7
6	16.2 cde	22.7	13.2 bcdef	264.8 cdefg	6020.8 bcde	88.8
7	16.0 bcde	23.1	13.1 bcde	261.0 bcdef	6035.3 bcde	88.6
8	16.3 cde	24.2	13.4 ef	268.3 fg	6472.0 def	89.2
9	15.9 bc	23.3	13.0 bcd	259.3 bcd	6033.3 bcde	88.8
10	15.7 b	21.7	12.8 b	256.5 b	5574.5 bc	88.6
11	16.0 bcde	24.6	13.0 bcde	260.3 bcdef	6414.5 cdef	88.7
12	15.9 bcd	23.3	13.0 bcd	259.8 bcde	6042.8 bcde	88.8
13	16.2 cde	26.2	13.4 def	267.0 defg	7002.5 f	89.3
14	15.8 bc	21.8	12.9 bc	258.5 bc	5631.0 bcd	88.7
15	15.9 bcde	23.0	13.2 bcde	263.3 bcdefg	6038.0 bcde	89.4
16	16.3 de	21.9	13.3 cdef	266.8 defg	5852.3 bcd	88.8
17	16.2 bcde	22.7	13.3 cdef	265.3 cdefg	6022.5 bcde	89.0
18	16.2 bcde	22.2	13.3 cdef	265.0 cdefg	5886.8 bcd	88.9
19	16.1 bcde	23.7	13.2 bcdef	263.0 bcdef	6242.8 bcdef	88.7
20	16.0 bcde	22.5	13.1 bcde	262.3 bcdef	5887.3 bcd	88.9
Mean	16.0	22.9	13.1	262.3	6022.1	88.9
CV%	1.88	9.88	2.16	2.19	10.20	0.50
Pr>F	<.0001	0.1652	<.0001	<.0001	0.0122	0.0984
lsd (0.05)	0.43	NS	0.40	8.1	868.6	NS

Table 1: Yield parameter results for the CLS x Fertility Trial. Values with different letters are significantly different.

Trt #	11-Aug	20-Aug	31-Aug	10-Sep	21-Sep	1-Oct
1	3.10 a	5.55 a	8.65 a	9.00 a	9.00 a	9.00 a
2	1.40 d	2.30 b	3.30 c	4.70 cde	5.95 defg	6.78 def
3	1.83 b	2.58 b	3.55 bc	4.95 bcde	6.23 bcde	6.95 cd
4	1.60 bcd	2.20 b	3.20 c	4.55 de	5.65 g	6.53 f
5	1.43 cd	2.25 b	3.40 bc	4.43 e	5.83 efg	6.65 def
6	1.73 bcd	2.48 b	3.50 bc	4.78 bcde	5.80 fg	6.70 def
7	1.53 bcd	2.55 b	3.43 bc	4.73 cde	6.08 cdef	6.85 cdef
8	1.65 bcd	2.58 b	3.45 bc	4.88 bcde	5.93 defg	6.78 def
9	1.58 bcd	2.38 b	3.58 bc	4.95 bcde	6.18 bcdef	6.73 def
10	1.65 bcd	2.30 b	3.88 b	5.30 b	6.55 b	7.50 b
11	1.65 bcd	2.48 b	3.45 bc	5.00 bcd	6.28 bcd	7.18 bc
12	1.73 bcd	2.33 b	3.68 bc	5.18 bc	6.40 bc	7.15 bc
13	1.65 bcd	2.55 b	3.35 bc	5.05 bcd	6.18 bcdef	6.90 cde
14	1.68 bcd	2.45 b	3.43 bc	4.70 cde	5.93 defg	6.65 def
15	1.53 bcd	2.38 b	3.38 bc	4.80 bcde	6.15 bcdef	6.90 cde
16	1.53 bcd	2.33 b	3.43 bc	4.58 de	5.90 defg	6.58 ef
17	1.40 d	2.20 b	3.48 bc	4.53 de	5.95 defg	6.65 def
18	1.53 bcd	2.55 b	3.38 bc	4.88 bcde	5.83 efg	6.85 cdef
19	1.80 bc	2.30 b	3.43 bc	4.75 bcde	5.78 fg	6.70 def
20	1.65 bcd	2.53 b	3.60 bc	4.73 cde	5.85 efg	6.70 def
Mean	1.7	2.6	3.7	5.0	6.2	6.9
CV%	16.3	13.5	10.7	8.0	4.7	3.7
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.39	0.49	0.57	0.57	0.41	0.36

Table 2: Foliar ratings for the CLS x Fertility Trial using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different.

Trt #	Treatment Description		Rate/Acre	Application Code
1	Control	n/a	n/a	ABCDEF
2	Standard Fertility (Standard)	SuperTin	8 oz	ACE
		Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
3	High Fertility	SuperTin	8 oz	ACE
		Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
4	Standard/Beet Boost	SuperTin	8 oz	ACE
		Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Beet Boost	32 oz	BD
5	Standard	SuperTin	8 oz	ACE
	Ascend Pro 4.7oz/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
	Ascend SL 4.7oz/acre (6-8lf)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Max-In Boron	1 pt	AD
		Voyagro	1 pt	AD
		Ascend SL	4.7 oz	A
6	Standard	SuperTin	8 oz	ACE
	Generate 1 pint/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
7	Standard	SuperTin	8 oz	ACE
	Zypro 8oz/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
8	Standard/Coron	SuperTin	8 oz	ACE
		Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Coron	1 gal	BDF
9	Standard	SuperTin	8 oz	ACE
	Pro-Germ + Sure-K + Micro 500	Masterlock	6.4 oz	ABCDEF
	(infurrow)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
10	Standard/Nresponse + Micro 500	SuperTin	8 oz	ACE
	Pro-Germ + Sure-K + Micro 500	Masterlock	6.4 oz	ABCDEF
	(infurrow)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Micro 500	1 qt	ABCDEF
		Nresponse	1 gal	ABCDEF
11	Standard/Sugar and Spice	SuperTin	8 oz	ACE
	Pro-Germ + Sure-K + Micro 500	Masterlock	6.4 oz	ABCDEF
	(infurrow)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Sugar and Spice	1 gal	ABCDEF
12	Standard/FP-16	SuperTin	8 oz	ACE
	Pro-Germ + Sure-K + Micro 500	Masterlock	6.4 oz	ABCDEF
	(infurrow)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		FP-16	1 gal	ABCDEF
13	Standard/fertiRain	SuperTin	8 oz	ACE
	Pro-Germ + Sure-K + Micro 500	Masterlock	6.4 oz	ABCDEF
	(infurrow)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		fertiRain	1 gal	ABCDEF
14	Standard/TakeOff LS	SuperTin	8 oz	ACE
		Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		TakeOff LS	1 pt	AC
15	Standard	SuperTin	8 oz	ACE
	Ascend Pro 4.7oz/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
16	Standard	SuperTin	8 oz	ACE
	Ascend Pro 4.7oz/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
	Ascend SL 4.7oz/acre (6-8lf)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
17	Standard	SuperTin	8 oz	ACE
	Ascend SL 4.7oz/acre (6-8lf)	Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
18	Standard/Max-In Boron+Voyagro	SuperTin	8 oz	ACE
		Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Voyagro	1 pt	AD
		Max-In Boron	1 pt	AD
19	Standard/Max-In Boron+Voyagro	SuperTin	8 oz	ACE
	Ascend Pro 4.7oz/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
	Ascend SL 4.7oz/acre (6-8lf)	Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Max-In Boron	1 pt	AD
		Voyagro	1 pt	AD
20	Standard/Vitazyme	SuperTin	8 oz	ACE
	Vitazyme 12.8oz/acre (infurrow)	Masterlock	6.4 oz	ABCDEF
		Inspire XT	7 oz	B
		Badge SC	32 oz	CF
		Manzate Prostick	2 lbs	ABDE
		Proline	5.7 oz	F
		Eminent VP	13 oz	D
		Vitazyme	12.8 oz	CE

Table 3: CLS x Fertility Trial treatment list.

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.

Materials and Methods: Two trials were conducted as randomized complete block 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 27th using 3gpa of 6-24-6 starter fertilizer applied in-furrow. The Hector Trial was planted on May 5th using 3gpa of 6-24-6 starter fertilizer applied in-furrow. 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 July 6th at Clara City and July 10th at Hector. Fungicide applications began July 9th at Clara City and July 16th at Hector and continued on a ten to twelve-day spray interval. Applications were made using a custom-made tractor sprayer traveling 3.6mph 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 CO2 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 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 25th at Clara City and October 9th 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 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). The 4.0 variety in combination with a tank-mixed 6 spray program had the highest percent sugar and extractable sugar per ton. However, the 2.0 variety tended to have higher tons per acre and extractable sugar per acre when compared to the 4.0 variety across the same fungicide programs. There were also many significant differences in the foliar ratings (Table 2). The 2.0 variety had the lowest foliar ratings when compared across fungicide programs to the other varieties. None of the fungicide programs provided acceptable control for the 4.0 variety. The 6 spray tank-mixed program did provided adequate control for the 3.0 variety. Excluding the check, all of the fungicide programs provided acceptable control for the 2.0 variety. The disease ratings show that the new CLS tolerance of the 2.0 variety is not immunity to the disease. A fungicide program will be required to maintain CLS control on these new varieties.

Trt #	Variety	Fungicide Program	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	2.0	Check	15.7 gh	30.9 efgh	13.2 gh	263.8 gh	8140.5 efg	90.8 a
2	2.0	3 Spray Program (ACE)	17.1 bc	35.9 b	14.5 abc	289.3 abc	10373.5 ab	90.9 a
3	2.0	6 Spray Program	16.8 bcde	39.0 a	14.1 bcde	282.8 bcde	11007.5 a	90.6 ab
4	2.0	3 Spray No Tank-Mix (ACE)	16.5 cdef	35.4 bc	13.9 cdef	278.0 cdef	9842.8 bcd	90.8 a
5	2.0	6 Spray No Tank-Mix	16.8 bcde	33.1 bcde	14.2 bcde	283.0 bcde	9378.0 cd	90.6 ab
6	2.0	3 Spray No Tank-Mix (CDE)	16.4 def	35.9 b	13.8 defg	275.3 defg	9872.0 bc	90.5 abcd
7	3.0	Check	14.8 i	25.3 k	12.2 j	244.8 j	6180.8 j	89.8 d
8	3.0	3 Spray Program (ACE)	16.6 cde	29.9 ghi	14.0 cde	279.5 cde	8312.0 ef	90.6 abc
9	3.0	6 Spray Program	17.0 bcd	31.1 efgh	14.3 bcd	286.5 bcd	8913.3 def	90.6 ab
10	3.0	3 Spray No Tank-Mix (ACE)	16.7 cde	28.7 hij	14.0 cde	279.5 cde	8029.0 fgh	90.2 abcd
11	3.0	6 Spray No Tank-Mix	16.7 cde	32.0 defg	14.1 bcde	281.8 bcde	9001.0 cde	90.8 a
12	3.0	3 Spray No Tank-Mix (CDE)	15.7 g	27.8 ijk	13.1 hi	261.0 hi	7258.8 ghi	90.0 bcd
13	4.0	Check	15.1 hi	26.0 jk	12.5 ij	249.8 ij	6493.8 ij	89.9 cd
14	4.0	3 Spray Program (ACE)	17.1 abc	34.4 bcd	14.4 abc	288.0 abcd	9879.5 bc	90.4 abcd
15	4.0	6 Spray Program	17.7 a	32.9 cdef	15.0 a	300.8 a	9881.5 bc	90.8 a
16	4.0	3 Spray No Tank-Mix (ACE)	16.3 efg	30.2 fghi	13.6 efgh	272.5 efgh	8221.5 ef	90.3 abcd
17	4.0	6 Spray No Tank-Mix	17.3 ab	33.3 bcde	14.7 ab	292.5 ab	9712.0 bcd	90.7 a
18	4.0	3 Spray No Tank-Mix (CDE)	15.9 fg	26.9 jk	13.3 fgh	266.0 fgh	7171.3 hi	90.3 abcd
		Mean	16.4	31.6	13.8	276.4	8759.4	90.5
		CV%	2.7	6.5	3.3	3.3	7.7	0.5
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.0469
		lsd (0.05)	0.64	2.92	0.64	12.8	951.0	0.68

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	29-Jul	7-Aug	17-Aug	26-Aug	4-Sep	14-Sep
1	2.0	Check	1.1 e	1.9 ef	2.7 ghi	5.1 ef	6.0 ef	6.7 d
2	2.0	3 Spray Program (ACE)	1.1 e	1.2 i	1.3 k	1.6 i	2.1 k	2.0 j
3	2.0	6 Spray Program	1.0 e	1.3 ghi	1.3 k	1.7 i	2.0 k	1.7 j
4	2.0	3 Spray No Tank-Mix (ACE)	1.1 e	1.1 i	1.3 k	2.0 i	2.8 j	2.9 i
5	2.0	6 Spray No Tank-Mix	1.1 e	1.3 hi	1.3 k	1.8 i	2.4 jk	2.0 j
6	2.0	3 Spray No Tank-Mix (CDE)	1.3 e	1.7 fgh	1.9 j	3.3 h	4.0 hi	4.0 h
7	3.0	Check	3.3 b	4.9 b	5.9 c	8.1 b	8.8 a	8.5 ab
8	3.0	3 Spray Program (ACE)	1.2 e	2.1 ef	2.6 ghi	4.0 g	4.7 g	5.4 f
9	3.0	6 Spray Program	1.3 e	2.0 ef	2.2 ij	3.3 h	3.7 i	4.2 h
10	3.0	3 Spray No Tank-Mix (ACE)	1.8 cd	3.3 c	3.8 de	5.8 d	6.7 cd	7.1 cd
11	3.0	6 Spray No Tank-Mix	1.1 e	1.8 fg	2.6 hi	4.0 g	4.4 gh	4.8 g
12	3.0	3 Spray No Tank-Mix (CDE)	3.6 b	4.7 b	5.5 c	6.5 c	7.2 c	7.4 c
13	4.0	Check	4.9 a	5.7 a	7.3 a	9.0 a	9.0 a	9.0 a
14	4.0	3 Spray Program (ACE)	1.8 d	2.8 d	3.5 ef	5.3 de	6.4 de	7.1 cd
15	4.0	6 Spray Program	1.2 e	2.3 e	2.8 gh	4.7 f	5.0 g	6.1 e
16	4.0	3 Spray No Tank-Mix (ACE)	2.2 c	3.6 c	4.3 d	6.5 c	7.9 b	8.3 b
17	4.0	6 Spray No Tank-Mix	1.2 e	2.1 ef	3.1 fg	5.1 ef	5.8 f	6.6 de
18	4.0	3 Spray No Tank-Mix (CDE)	4.7 a	5.8 a	6.5 b	8.0 b	9.0 a	9.0 a
		Mean	1.9	2.7	3.3	4.8	5.4	5.7
		CV%	17.2	11.6	11.1	9.6	8.0	6.6
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
		lsd (0.05)	0.47	0.45	0.52	0.64	0.61	0.53

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: This trial site received several large rain events during the growing season that led to saturated soil conditions and a reduced crop yield for the entire site. The differences in the yield parameters at this site where not as large as the differences at the Clara City site, however the trends remained similar (Table 3). This trial also had a reduced canopy which lead to CLS developing later in the season with a lower disease severity overall across the site (Table 4). Although the disease severity was lower the trend remained the same as at the Clara City site. The 2.0 variety had the lowest foliar ratings when compared across fungicide programs to the other varieties. None of the fungicide programs provided acceptable control for the 4.0 variety. The 6 spray tank-mixed program did provided adequate control for the 3.0 variety. Excluding the check, all of the fungicide programs provided acceptable control for the 2.0 variety. Similar to the Clara City site, the disease ratings show that the new CLS tolerance of the 2.0 variety is not immunity to the disease

Trt #	Variety	Fungicide Program	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	2.0	Control	15.7 efg	25.5 bcd	12.9 cdef	257.8 bcde	6557.0 bc	89.1
2	2.0	6 Spray Program	16.0 abcde	25.9 abc	13.2 abcd	262.5 abc	6831.3 ab	89.0
3	2.0	2 Spray Program (AC)	16.2 abcd	25.7 bc	13.4 ab	267.8 a	6877.8 ab	89.5
4	2.0	3 Spray Program (ABC)	15.8 bcdef	28.2 a	13.1 abcde	260.5 abcd	7343.5 a	89.3
5	2.0	3 Spray Program (CDE)	15.8 cdef	27.4 ab	13.0 abcdef	259.5 abcde	7113.3 ab	89.1
6	2.0	2 Spray Program (CE)	16.1 abcde	25.9 bc	13.3 abc	265.8 ab	6881.8 ab	89.3
7	3.0	Control	14.6 h	20.3 hi	11.9 g	237.8 f	4812.3 fg	88.8
8	3.0	6 Spray Program	16.2 abc	21.2 ghi	13.4 ab	268.3 a	5674.8 de	89.4
9	3.0	2 Spray Program (AC)	15.2 g	23.8 cdef	12.5 f	249.8 e	5939.0 cd	89.1
10	3.0	3 Spray Program (ABC)	15.5 fg	23.4 defg	12.7 def	254.5 cde	5978.0 cd	89.1
11	3.0	3 Spray Program (CDE)	15.7 def	20.3 hi	12.9 cdef	257.5 bcde	5215.0 ef	88.8
12	3.0	2 Spray Program (CE)	15.7 efg	21.9 fgh	13.0 bcdef	259.3 abcde	5678.0 de	89.7
13	4.0	Control	14.1 i	19.0 i	11.3 h	226.3 g	4302.5 g	88.1
14	4.0	6 Spray Program	16.3 ab	24.3 cde	13.5 a	268.5 a	6529.8 bc	89.4
15	4.0	2 Spray Program (AC)	15.5 fg	23.4 defg	12.6 ef	252.3 de	5891.3 cde	88.4
16	4.0	3 Spray Program (ABC)	16.3 a	22.1 efgh	13.4 ab	267.8 a	5931.8 cd	88.9
17	4.0	3 Spray Program (CDE)	16.2 acbd	22.6 efg	13.2 abc	264.8 ab	5980.3 cd	88.7
18	4.0	2 Spray Program (CE)	15.4 fg	22.5 efgh	12.7 ef	252.8 cde	5684.5 de	89.0
		Mean	15.7	23.5	12.9	257.4	6067.9	89.0
		CV%	2.13	6.80	2.69	2.73	7.91	0.67
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.0722
		lsd (0.05)	0.47	2.27	0.49	10.0	681.6	NS

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	11-Aug	20-Aug	31-Aug	10-Sep	21-Sep	1-Oct
1	2.0	Control	1.2 efg	1.8 defg	3.1 ef	3.6 fg	3.9 g	4.6 h
2	2.0	6 Spray Program	1.0 g	1.4 fg	1.5 i	1.5 i	1.9 jk	2.1 k
3	2.0	2 Spray Program (AC)	1.1 fg	1.4 fg	1.8 hi	1.9 hi	2.8 hi	2.7 j
4	2.0	3 Spray Program (ABC)	1.0 g	1.2 g	1.7 i	1.6 i	2.1 jk	2.4 jk
5	2.0	3 Spray Program (CDE)	1.2 efg	1.5 efg	1.7 i	1.6 i	1.8 k	1.5 l
6	2.0	2 Spray Program (CE)	1.3 defg	1.8 def	2.4 g	2.2 h	2.4 ij	2.7 j
7	3.0	Control	1.4 def	2.8 b	5.9 b	7.1 b	7.6 c	8.0 bc
8	3.0	6 Spray Program	1.1 fg	1.4 efg	1.6 i	2.3 h	3.3 h	4.0 i
9	3.0	2 Spray Program (AC)	1.3 defg	1.3 fg	3.3 e	4.8 e	5.5 e	7.0 e
10	3.0	3 Spray Program (ABC)	1.0 g	1.3 fg	2.3 gh	3.9 f	5.1 ef	6.3 f
11	3.0	3 Spray Program (CDE)	1.7 cd	2.5 bc	2.5 fg	3.4 fg	3.9 g	5.5 g
12	3.0	2 Spray Program (CE)	1.8 bc	2.7 b	4.0 d	4.9 e	5.6 e	7.4 de
13	4.0	Control	2.1 ab	4.1 a	7.7 a	9.0 a	9.0 a	9.0 a
14	4.0	6 Spray Program	1.3 defg	1.8 def	2.8 efg	3.1 g	5.0 f	6.2 f
15	4.0	2 Spray Program (AC)	1.5 cde	2.3 bcd	4.4 cd	6.4 c	7.8 bc	8.5 ab
16	4.0	3 Spray Program (ABC)	1.2 efg	1.9 cde	3.0 ef	5.2 e	6.9 d	7.7 cd
17	4.0	3 Spray Program (CDE)	2.4 a	3.7 a	4.6 c	5.8 d	6.4 d	7.3 de
18	4.0	2 Spray Program (CE)	2.4 a	3.9 a	5.4 b	6.7 bc	8.2 b	8.7 a
		Mean	1.4	2.2	3.3	4.2	4.9	5.6
		CV%	19.5	18.1	12.3	9.3	7.5	6.6
		Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
		lsd (0.05)	0.40	0.55	0.58	0.55	0.53	0.53

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: There are genetic differences in the yield potential of the varieties evaluated in these trials. The 2.0 variety has a higher tons per acre potential while its sugar content is lacking compared to the 4.0 variety. The 2.0 variety clearly does not need the same rigorous fungicide program that the 4.0 variety needs in order maintain extractable sugar per acre in a high disease pressure situation. 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. However, 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.

Trt #	Variety	Fungicide Program		Rate/Acre	Application Code
1	2.0	Control	n/a	n/a	ABCDEF
2	2.0	3 Spray Program	SuperTin	8 oz	AE
			Masterlock	6.4 oz	ACE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	ACE
3	2.0	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Badge SC	32 oz	CF
			Manzate Prostick	2 lbs	ABDE
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
4	2.0	3 Spray No Tank-Mix	SuperTin	8 oz	A
			Masterlock	6.4 oz	ACE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	E
5	2.0	6 Spray No Tank-Mix	SuperTin	8 oz	CE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	AD
			Proline	5.7 oz	F
6	2.0	3 Spray No Tank-Mix	SuperTin	8 oz	D
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	E
7	3.0	Control	n/a	n/a	ABCDEF
8	3.0	3 Spray Program	SuperTin	8 oz	AE
			Masterlock	6.4 oz	ACE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	ACE
9	3.0	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Badge SC	32 oz	CF
			Manzate Prostick	2 lbs	ABDE
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
10	3.0	3 Spray No Tank-Mix	SuperTin	8 oz	A
			Masterlock	6.4 oz	ACE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	E
11	3.0	6 Spray No Tank-Mix	SuperTin	8 oz	CE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	AD
			Proline	5.7 oz	F
12	3.0	3 Spray No Tank-Mix	SuperTin	8 oz	D
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	E
13	4.0	Control	n/a	n/a	ABCDEF
14	4.0	3 Spray Program	SuperTin	8 oz	AE
			Masterlock	6.4 oz	ACE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	ACE
15	4.0	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Badge SC	32 oz	CF
			Manzate Prostick	2 lbs	ABDE
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
16	4.0	3 Spray No Tank-Mix	SuperTin	8 oz	A
			Masterlock	6.4 oz	ACE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	E
17	4.0	6 Spray No Tank-Mix	SuperTin	8 oz	CE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	AD
			Proline	5.7 oz	F
18	4.0	3 Spray No Tank-Mix	SuperTin	8 oz	D
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	E

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	2.0	Control	n/a	n/a	ABCDEF
2	2.0	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Badge SC	32 oz	CF
			Manzate Prostick	2 lbs	ABDE
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
3	2.0	2 Spray Program	SuperTin	8 oz	A
			Masterlock	6.4 oz	AC
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	AC
4	2.0	3 Spray Program	SuperTin	8 oz	AC
			Masterlock	6.4 oz	ABC
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABC
5	2.0	3 Spray Program	SuperTin	8 oz	CE
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	D
			Manzate Prostick	2 lbs	CDE
6	2.0	2 Spray Program	SuperTin	8 oz	C
			Masterlock	6.4 oz	CE
			Inspire XT	7 oz	E
			Manzate Prostick	2 lbs	CE
7	3.0	Control	n/a	n/a	ABCDEF
8	3.0	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Badge SC	32 oz	CF
			Manzate Prostick	2 lbs	ABDE
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
9	3.0	2 Spray Program	SuperTin	8 oz	A
			Masterlock	6.4 oz	AC
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	AC
10	3.0	3 Spray Program	SuperTin	8 oz	AC
			Masterlock	6.4 oz	ABC
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABC
11	3.0	3 Spray Program	SuperTin	8 oz	CE
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	D
			Manzate Prostick	2 lbs	CDE
12	3.0	2 Spray Program	SuperTin	8 oz	C
			Masterlock	6.4 oz	CE
			Inspire XT	7 oz	E
			Manzate Prostick	2 lbs	CE
13	4.0	Control	n/a	n/a	ABCDEF
14	4.0	6 Spray Program	SuperTin	8 oz	ACE
			Masterlock	6.4 oz	ABCDEF
			Inspire XT	7 oz	B
			Badge SC	32 oz	CF
			Manzate Prostick	2 lbs	ABDE
			Proline	5.7 oz	F
			Eminent VP	13 oz	D
15	4.0	2 Spray Program	SuperTin	8 oz	A
			Masterlock	6.4 oz	AC
			Inspire XT	7 oz	C
			Manzate Prostick	2 lbs	AC
16	4.0	3 Spray Program	SuperTin	8 oz	AC
			Masterlock	6.4 oz	ABC
			Inspire XT	7 oz	B
			Manzate Prostick	2 lbs	ABC
17	4.0	3 Spray Program	SuperTin	8 oz	CE
			Masterlock	6.4 oz	CDE
			Inspire XT	7 oz	D
			Manzate Prostick	2 lbs	CDE
18	4.0	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.

EBDC Efficacy 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. 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 optimizing the performance of the fungicides currently available.

Objective: Trials need to be conducted to test the efficacy of individual fungicides and determine if there are any other practices that could improve the performance of fungicides that are currently available. EBDC fungicides are currently one of the most used fungicides. However, these are protectant products that need good leaf coverage and longevity to provide protection. Any practices that would improve leaf coverage or weatherability on the leaf surface should improve disease control.

Materials and Methods: This was conducted as randomized complete block with four replications near Hector, MN. This trial evaluated different EBDC fungicide formulations along with adjuvants. This site was planted on May 5th using Crystal 018 with 3gpa of 6-24-6 starter fertilizer applied in-furrow. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 1.5 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 10th. Six fungicide applications were made beginning July 16th and continuing on a ten to twelve-day spray interval. Treatments are shown in Table 3. Applications were made using a custom-made tractor sprayer traveling 3.6mph 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 CO2 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 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 October 9th 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 tare lab. The data was analyzed for significance using SAS version 9.4.

Results: This trial site received several large rain events during the growing season that led to saturated soil conditions and a reduced crop yield for the entire site. There are some differences in the yield and quality parameters with the check and the Masterlock + Transfix without fungicide treatment having significantly lower percent sugar and ESA than the majority of the other treatments (Table 1). The Manzate + Masterlock + Cuprofix had the highest ESA numerically, although not significant. This treatment did have a significantly lower CLS rating than all of the other treatments during the majority of the rating periods (Table 2).

Conclusion: The purpose of this trial was to identify a new practice or product that would improve the disease control of the EBDC products. Cuprofix is a copper fungicide which provided slightly better disease control than Manzate Prostick alone. None of the different EBDC formulations or adjuvants testing improved the disease control or yield in a meaningful way. Further testing needs to be done to improve the efficacy of the EBDC products as this is only one year of data on a site that received significant rainfall that impacted yield.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	14.1 c	17.6	11.3 c	227.0 c	3995.3 d	88.1 d
Manzate Prostick	15.8 ab	20.3	12.9 ab	258.2 ab	5224.8 ab	88.7 bcd
Manzate Prostick + Masterlock	15.7 ab	20.1	13.0 ab	259.0 ab	5220.8 ab	89.2 ab
Manzate Max	15.6 ab	19.7	12.7 b	253.2 b	4987.6 ab	88.5 cd
Manzate Max + Masterlock	15.7 ab	20.8	12.8 ab	255.8 ab	5312.7 ab	88.7 bcd
Manzate Prostick + Masterlock + Transfix	15.7 ab	20.2	12.9 ab	257.4 ab	5194.8 ab	89.0 abc
Manzate Prostick + Masterlock + Cuprofix	16.1 a	20.6	13.4 a	266.6 a	5487.0 a	89.5 a
Manzate Prostick & LI700	15.5 b	20.1	12.7 b	252.6 b	5061.8 ab	88.6 bcd
Dithane Rainshield	15.4 b	20.6	12.6 b	251.2 b	5154.2 ab	88.7 bcd
Manzate Prostick & Strikelock	15.5 b	18.8	12.6 b	252.0 b	4745.8 bc	88.7 bcd
Masterlock & Transfix	14.1 c	18.5	11.4 c	227.3 c	4182.2 cd	88.4 cd
Manzate Prostick & Masterlock & Citric Acid	15.7 ab	20.6	12.9 ab	257.0 ab	5306.2 ab	89.0 abc
Mean	15.4	19.8	12.6	251.4	4989.4	88.8
CV%	2.7	9.2	3.3	3.3	9.1	0.5
Pr>F	<.0001	0.3192	<.0001	<.0001	0.0007	0.0201
lsd (0.05)	0.61	NS	0.61	11.92	652.3	0.68

Table 1: Yield parameter results for the EBDC Efficacy Trial. Values with different letters are significantly different.

Treatment	11-Aug	20-Aug	31-Aug	10-Sep	21-Sep	1-Oct
Check	2.3 a	5.4 a	8.7 a	9.0 a	9.0 a	9.0 a
Manzate Prostick	1.4 e	2.9 bc	5.0 b	6.1 cde	7.2 cde	8.0 b
Manzate Prostick + Masterlock	1.5 de	2.8 bc	5.0 b	6.2 bcde	7.2 bcd	8.0 b
Manzate Max	1.7 bcde	2.9 bc	4.9 b	6.4 bc	7.5 b	8.0 b
Manzate Max + Masterlock	1.9 bc	3.2 b	4.9 b	6.4 b	7.3 bc	7.9 b
Manzate Prostick + Masterlock + Transfix	1.5 cde	2.9 bc	4.7 b	6.1 cde	7.0 def	7.8 bc
Manzate Prostick + Masterlock + Cuprofix	1.5 cde	2.5 c	4.1 c	5.7 f	6.6 f	7.4 d
Manzate Prostick & LI700	1.5 de	2.6 c	4.9 b	6.1 de	7.1 cde	7.6 c
Dithane Rainshield	1.8 bcd	3.2 b	5.1 b	6.4 bcd	7.2 bcd	7.9 b
Manzate Prostick & Strikelock	1.4 e	2.5 c	4.9 b	6.0 e	6.8 ef	7.8 bc
Masterlock & Transfix	2.1 ab	5.0 a	8.8 a	9.0 a	9.0 a	9.0 a
Manzate Prostick & Masterlock & Citric Acid	1.4 e	2.7 c	4.9 b	6.2 bcde	7.1 cde	7.9 b
Mean	1.6	3.2	5.5	6.6	7.4	8.0
CV%	16.5	9.8	6.0	3.0	3.1	2.4
Pr>F	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.39	0.45	0.48	0.29	0.33	0.27

Table 2: Foliar ratings for the EBDC Efficacy Trial using the KWS rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different.

Trt #	Treatment	Application Rate/Acre
1	n/a	n/a
2	Manzate Prostick	2 lbs
3	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
4	Manzate Max	51.2 oz
5	Manzate Max	51.2 oz
	Masterlock	6.4 oz
6	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
	Transfix	4 oz
7	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
	Cuprofix	2 lbs
8	Manzate Prostick	2 lbs
	LI700	6.4 oz
9	Dithane Rainshield	51.2 oz
10	Manzate Prostick	2 lbs
	Strikelock	4 oz
11	Masterlock	6.4 oz
	Transfix	4 oz
12	Manzate Prostick	2 lbs
	Masterlock	6.4 oz
	Citric Acid	4 oz

Table 3: EBDC Efficacy Trial treatment list.

INTEGRATED MANAGEMENT OF RHIZOCTONIA ON SUGARBEET WITH RESISTANT VARIETIES, AT-PLANTING TREATMENTS, AND POSTEMERGENCE FUNGICIDES, 2020

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Rhizoctonia damping-off and crown and root rot (RCRR) caused by *Rhizoctonia solani* AG 2-2 have been the most common root diseases on sugarbeet in Minnesota and North Dakota for several years (1,2). These diseases can occur throughout the growing season and reduce plant stand, root yield, and quality (3-7). Warm and wet soil conditions favor infection by *R. solani*. Disease management options include rotating with non-host crops (cereals), planting partially resistant varieties, planting early when soil temperatures are cool, improving soil drainage, and applying fungicides as seed treatments, in-furrow (IF), or postemergence. An integrated approach involving multiple strategies should help managing Rhizoctonia crown and root rot (4-7).

OBJECTIVES

Field trials were established to evaluate an integrated management strategy consisting of a resistant (R) and a moderately susceptible (MS) variety with at-panting treatments alone and in combination with two different postemergence azoxystrobin application timings for 1) control of early-season damping-off and RCRR and 2) effect on plant stand, yield and quality of sugarbeet.

MATERIALS AND METHODS

The field trial was established at three locations: (1) University of Minnesota, Northwest Research and Outreach Center, Crookston, (2) Minn-Dak Farmers Cooperative, Wahpeton (MDFC), ND, (3) Southern Minnesota Beet Sugar Cooperative (SMBSC), Renville, MN. All locations were fertilized for optimal yield and quality. At each location, a combination of a resistant (R) and moderately susceptible (MS) varieties treated with fluxapyroxad (Systiva), in-furrow azoxystrobin (Quadris) on fluxapyroxad (Systiva), or untreated seed was planted in four replicate plots (Table 1). An additional treatment consisting of in-furrow azoxystrobin on untreated seed was included at the NWROC site. Plots were set up in a split-split plot design at all 3 locations. Main plots were varieties, the first split was at-panting treatments, and the last split was postemergence azoxystrobin timings. Systiva was used at 5 g ai/unit seed and applied by Germains Seed Technology, Fargo, ND. Each variety by at-planting treatment combination was planted in triplicate, so that at the 4- or 8-leaf stage, one plot of each variety by at-planting treatment combination received a postemergence 7-inch band application of azoxystrobin (14.3 fl oz product A^{-1}) while one was left as a stand-alone treatment. Controls for each variety included no at-planting treatment with each postemergence azoxystrobin timing and without postemergence azoxystrobin. Two-year average Rhizoctonia ratings in American Crystal Sugar Company tests for the resistant and moderately susceptible varieties were 3.7 and 4.4, respectively (8).

NWROC site. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley broadcast at 50 kg ha^{-1} and incorporated with a Rau seedbed finisher. The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 19 at 4.5-inch seed spacing. Counter 20G (8.9 lb/A) was applied at planting and Lorsban (2 pt/A) was applied on June 05 for control of root maggot. Roundup Power Max (28 oz/A) on Jun 2, Sequence (glyphosate + S-metolachlor, 2.5 pt/A) + Roundup (8 oz/A) was applied on June 19 and Roundup Power Max (28 oz/A) on Jul 29 for control of weeds. Postemergence azoxystrobin was applied in a 7-inch band in 10 gallon/A using 4002 nozzles and 34 psi on June 12 (4-leaf stage, ~3.5 weeks after planting) or June 25 (8-leaf stage, ~5 weeks after planting). Cercospora leaf spot (CLS) was controlled by Minerva Duo (16 fl oz/A) on Aug 04 and Super Tin (8 oz) + Proline (5 oz/A) on Aug 24 applied in 20 gallons water/A at 100 psi. The trial was harvested on Sept 21.

MDFC site. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley (50 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 25-ft rows) on May 21 at 4.5-inch seed spacing. Dual Magnum (0.5 pt/A) + Ethofumesate 4SC (2 pt/A) was applied PRE on May 21. A tank-mix of Roundup PowerMax (5.5 lb product ae/gallon), N-tense (10 fl oz/A), Outlook (12 fl oz/A), and Ethofumesate 4SC (4 fl oz/A) was applied on June 19 and Outlook (12 fl oz/A) was applied on June 30. Postemergence azoxystrobin was applied in a 7-inch band on June 17 (5-leaf stage, 3 WAP) or June 24 (8-leaf stage, 4 WAP). Cercospora leaf spot was controlled by application of Provysol + Badge SC (5 oz/A+2 pt/A) on Jul 2, AgriTin + Manzate (8 fl oz/A+52 fl oz/A) on Jul 10, Proline 480 SC + Badge SC + Prefer 90 (5.7 fl oz/A+2 pt/A+0.125% v/v) on Jul 20, AgriTin + Manzate (8 fl oz/A+52 fl oz/A) on Jul 27, Inspire + Badge SC (7 fl oz/A+2 pt/A) on Aug 8, AgriTin + Manzate (8 fl oz/A+52 fl oz/A) on Aug 19, and Badge SC (4 pt/A) on Sept 2. All fungicides for CLS control were applied utilizing a 3pt-mounted sprayer dispersing the products in broadcast pattern at a water volume of 20 GPA with TeeJet 11002 air induction nozzles at 40 psi. The trial was harvested on Sept 29.

Table 1. Application type, product names, active ingredients, and rates of fungicides used at planting in a field trial for control of *Rhizoctonia solani* AG 2-2 on sugarbeet. Each at-plant treatment was used in combination with a Rhizoctonia resistant (2-year average rating = 3.7) and moderately susceptible (2-year average rating = 4.4) variety, and all treatment combinations in triplicate, with one set receiving a postemergence 7-inch band application of azoxystrobin (14.3 fl oz A^{-1}) at 4- or 8-leaf stage. Standard rates of Apron + Thiram and 45 g/unit Tachigaren were on all seed.

Application	Product	Active ingredient	Rate
None	-	-	-
Seed	Systiva	Fluxapyroxad	5 g a.i./unit seed
In-furrow	Quadris	Azoxystrobin	9.5 fl oz product A^{-1}

Table 2. Monthly precipitation in inches at three sites during 2020 crop season based on weather stations.

	Precipitation in inches		
Month	NWROC	MDFC	SMBSC
April	1.92	2.05	0.19
May	1.00	0.91	0.55
June	4.52	2.98	4.15
July	7.52	6.35	2.94
August	3.02	3.59	4.07
September	0.44	0.88	1.69
October	0.49	0.86	0.99
Total	**18.91**	**17.62**	**14.58**

SMBSC site. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley (50 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 35-ft rows) on May 07 at 4.77-inch seed spacing. Inoculum was incorporated using the 8.5 foot field cultivator followed by a drag. Weeds were controlled using a preemergence application of Dual Magnum (0.5 pt/A) plus Norton (2 pt/A) and by postemergence applications of Roundup PowerMax (32 oz/A) on Jun 03 followed by Sequence (2.5 pts/A) on Jun 12 and Jun 23. Postemergence azoxystrobin timings were applied on June 09 (4-leaf, ~5 weeks after planting), or June 22 (8-leaf, ~6.5 weeks after planting) as 7 inch bands using 4001E nozzles at 35 psi. Cercospora leaf spot was managed by fungicide applications of Agritin + Dithane on Jul 03, Inspire XT + Dithane on Jul 13, SuperTin + Dithane on Jul 22, Minerva + Badge on Aug 03, SuperTin + Dithane on Aug 18, and Provysol + Dithane on Aug 27. All fungicides for CLS control were applied in a water volume of 21 GPA with 110025 nozzles at 50 psi. The trial was harvested on Sept 16.

At NWROC stand counts were done beginning 2 weeks after planting through 11 weeks after planting. At MDFC stand counts were done 2, 3.5, 4 and 5 weeks after planting. At SMBSC stand counts were done 3, 5, and 7 weeks after planting (WAP). Data were collected for number of harvested roots (NWROC and SMBSC), yield, and quality. Twenty roots per plot also were arbitrarily selected and rated for severity of RCRR using a 0 to 10 scale with 10%

increment for each point (0 = 0%, healthy root; 10 = 100%, root completely rotted). Disease incidence was reported as the percent of rated roots with a root rot rating > 0.

Data were subjected to analysis of variance using SAS Proc GLM (SAS Institute, Cary, NC) for main effects of variety, at-plant treatment, postemergence azoxystrobin application, and all possible interactions. Means were separated by Fisher's Protected Least Significant Difference ($P = 0.05$).

RESULTS AND DISCUSSION

NWROC site: Early part of the 2020 growing season was dry at the NWROC during the period of May – early June resulting in lower early season disease pressure. Rainfall at the NWROC was just 1.00 in. during the month of May compared to a 30-year average of 2.44. Resistant (R) and moderately susceptible (MS) varieties had similar stands from 2 to 11 weeks after planting (WAP). AT 2, 3 and 5 WAP, Systiva, Systiva + Quadris in-furrow (I-F) had higher stands followed by untreated + Quadris I-F and lowest for untreated control plots. At 4 and 6 to 11 WAP, Systiva and Systiva + Quadris I-F had higher stands followed by Systiva and untreated + Quadris I-F and lowest for untreated plots. Quadris in-furrow application caused some stand loss whereas Quadris I-F on Systiva treated seed did not show this stand reduction in 2020. Control plants had 165 plants/100 ft. row at 4.5 WAP indicating low early season disease pressure. Stand reduction with Quadris was also observed in 2017 to 2019 (4-6). Very low root rot severity and incidence were observed for both varieties at harvest. Moderately susceptible variety had significantly lower percent sucrose and higher recoverable sucrose A^{-1} (RSA) (Table 3). Significant variety by postemergence treatment interaction was observed for RSA (Table 3). Both 4- and 8-leaf postemergence applications resulted in higher RSA for both varieties but susceptible variety had much higher recovery of RSA compare to the resistant variety (Fig. 2). A significant at-plant by postemergence treatment interaction was observed for root rot severity and incidence, root yield and RSA (Table 3). Both 4- and 8-leaf postemergence applications on untreated seed, Systiva, and Systiva + Quadris I-F resulted in higher RSA with more RSA recovery on untreated and Systiva seed compared to Systiva + Quadris I-F treatment (Fig. 3). Both 4- and 8-leaf postemergence applications resulted in lower root rot with 8-leaf stage better compared to the 4-leaf stage (Fig. 4).

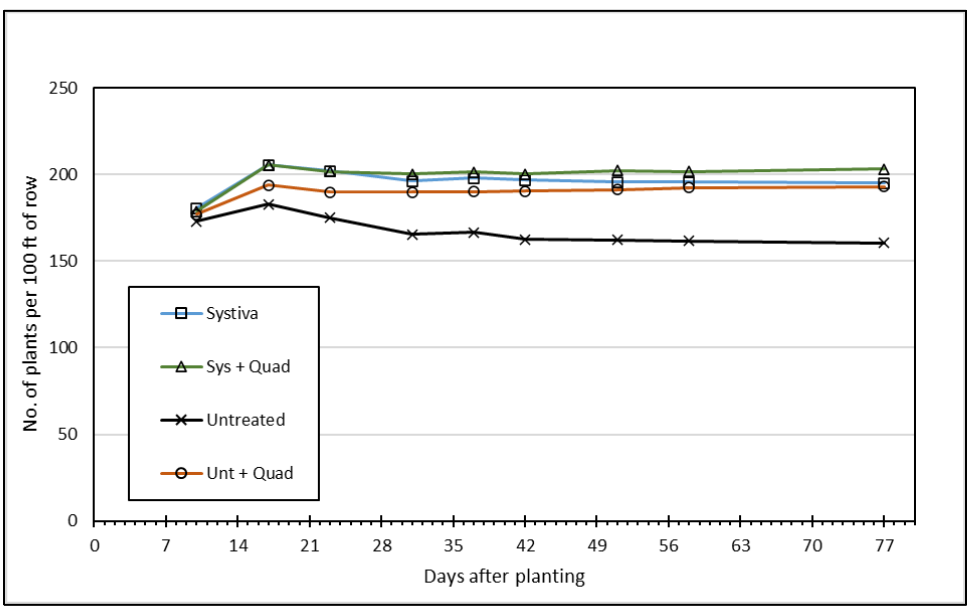

Fig. 1. NWROC site: Emergence and stand establishment for fungicide treatments at-planting or untreated control. Statistical significance of data at each timepoint was discussed in the text. Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

Table 3. **NWROC site:** Main effects of variety, at-planting, and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial sown May 16, 2019.

Main effect (Apron + Maxim on all seed)	No. harv. roots/100 ft[T]	RCRR (0-10)[TU]	RCRR % incidence[TV]	Yield ton A^{-1}[T]	Sucrose[T] %	Sucrose[T] lb ton^{-1}	Sucrose[T] lb A^{-1}
Variety[W]							
Resistant	160	0.75	20	22.5 b	18.5 a	347	7809 b
Moderately Susceptible	167	1.04	22	27.0 a	17.9 b	335	9048 a
ANOVA p-value	0.1998	0.2003	0.5228	0.0011	0.0452	0.0553	0.0016
At-planting treatments[X]							
Untreated control	144 c	1.35 b	27 b	24.2 bc	18.1	338	8155
Systiva	163 b	1.31 b	29 b	23.9 c	18.1	340	8108
Quadris In-furrow	171 a	0.58 a	18 a	25.4 ab	18.2	340	8596
Systiva + Quadris I-F	175 a	0.33 a	10 a	25.7 a	18.4	346	8857
ANOVA p-value	<0.0001	<0.0001	0.0002	0.0371	0.1731	0.1547	0.0063
LSD (*P* = 0.05)	7.7	0.3	7.8	1.4	NS	NS	448
Postemergence fungicide[Y]							
None	155 b	1.8 c	38 c	23.5 b	18.0 b	337 b	7921 b
4-leaf Quadris	169 a	0.7 b	18 b	25.2 a	18.3 a	343 a	8626 a
8-leaf Quadris	165 a	0.2 a	8 a	25.6 a	18.3 a	343 a	8739 a
ANOVA p-value	<0.0001	<0.0001	<0.0001	0.0002	0.0367	0.0460	<0.0001
LSD (*P* = 0.05)	5.2	0.24	4.0	0.98	0.20	4.7	332
Vty x at-plant	0.3200	0.1404	0.2079	0.9551	0.7743	0.7949	0.9188
Vty x Post	**0.0184**	0.2702	0.9188	0.0748	0.3426	0.3392	**0.0251**
At-plant x Post	**0.0015**	**<0.0001**	**<0.0001**	**0.0171**	0.1986	0.2448	**0.0019**
Vty x At-plant x Post	0.4754	0.3439	0.4536	0.6947	0.5382	0.6292	0.5773

T Numbers followed by the same letter are not significantly different; LSD = Least Significant Difference, *P* = 0.05; NS = not significantly different

U RCRR = Rhizoctonia crown and root rot; 0-7 scale (adjusted rating), 0 = root clean, no disease, 10 = root completely rotted and plant dead

V RCRR = Rhizoctonia crown and root rot; percent of roots with rating greater than two

W Values represent mean of 48 plots (4 replicate plots across 4 at-planting treatments and 3 postemergence treatments)

X Systiva @ 5 g a.i /unit and Quadris In-furrow @ 9.5 fl oz./A via drip tube; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

Y Quadris Postemergence @ 14.5 fl oz./A in a 7 inch band; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 at-planting treatments)

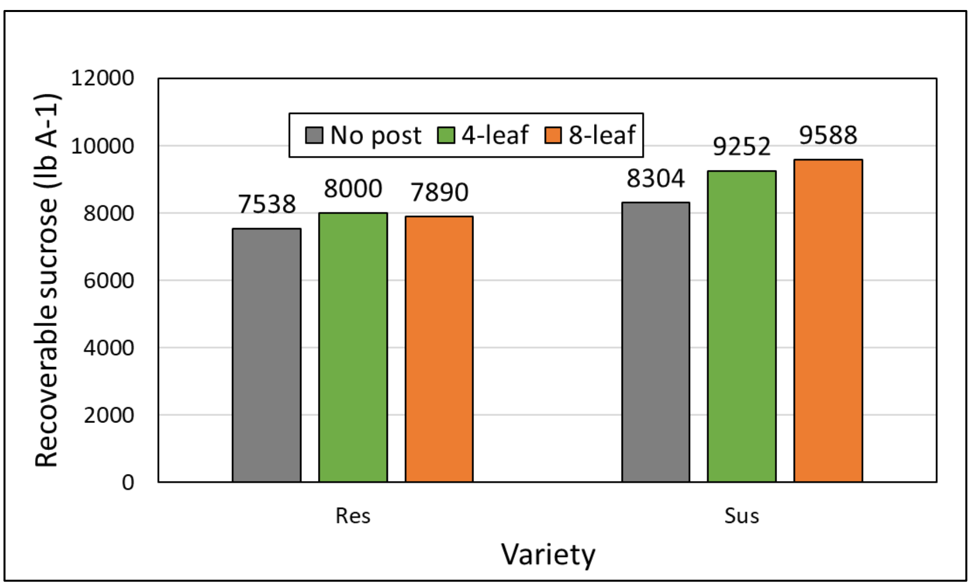

Fig. 2. NWROC site: Effect of variety and postemergence (PE) treatment interaction on recoverable sucrose. Data shown represents mean of 16 plots averaged across at-planting treatments.

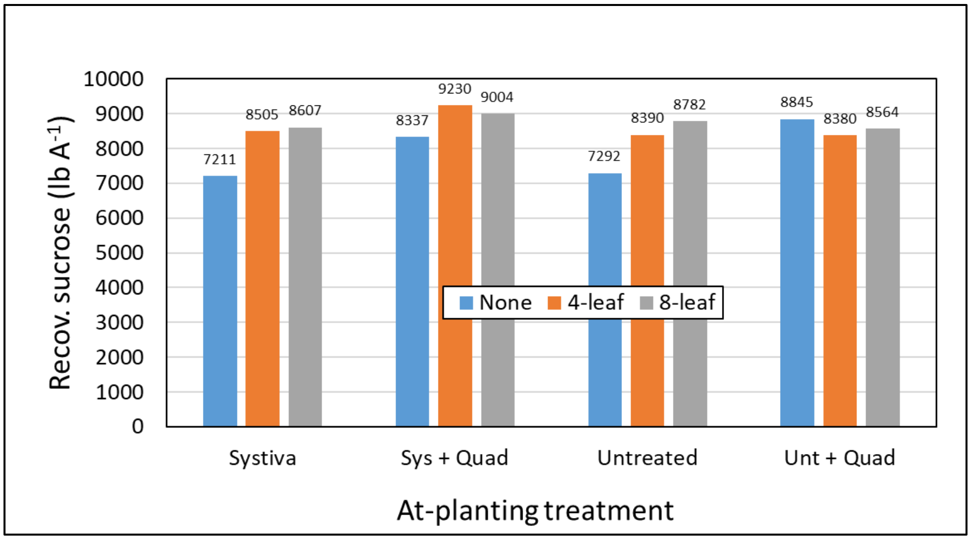

Fig. 3. NWROC site: Effect of at-panting and postemergence (PE) treatment interaction on recoverable sucrose. Data shown represents mean of 8 plots averaged across varieties.

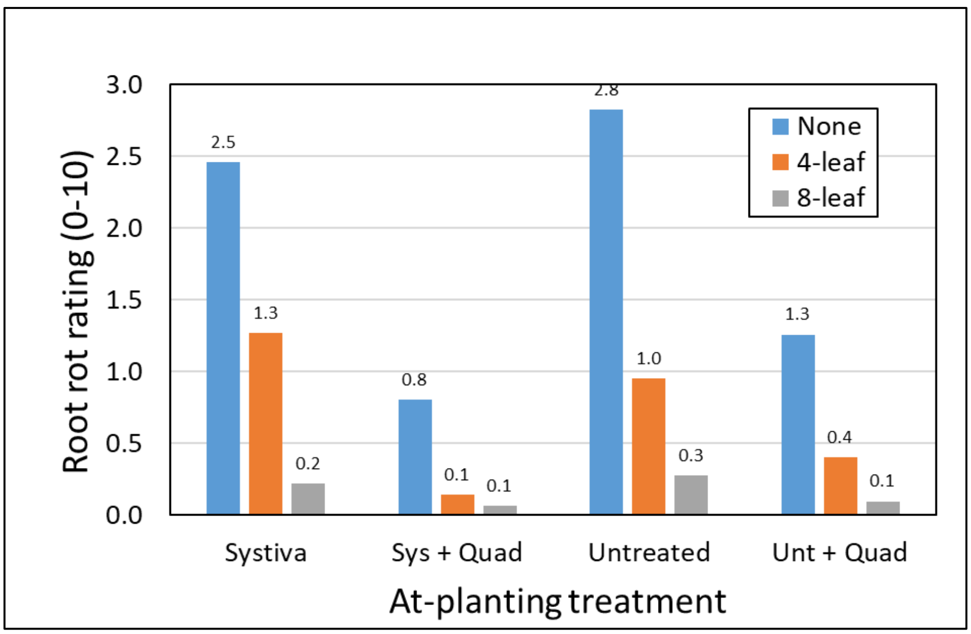

Fig. 4. NWROC site: Effect of at-panting and postemergence (PE) treatment interaction on Rhizoctonia root rot rating. Data shown represents mean of 8 plots averaged across varieties.

MDFC site: The Rhizoctonia disease pressure at this site was none to very low from planting until harvest and no statistical differences were observed for stand counts or harvest parameters except stands at 3 WAP were higher for the susceptible variety, root rot rating and % tare were lower at harvest for the susceptible variety, and purity was higher for the susceptible variety (Table 4). Variety x at-plant x postemergence treatment 3-way interaction was observed for root rot rating (Table 4).

Table 4. **MDFC site:** Main effects of variety, at-planting, and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial sown May 31, 2019.

Main effect (Apron + Maxim on all seed)	RCRR (0-10) [TU]	RCRR % incidence[TV]	Purity	% Tare	Yield ton A^{-1} [T]	Sucrose[T] %	Sucrose[T] lb ton^{-1}	Sucrose[T] lb A^{-1}
Variety[W]								
Resistant	0.3 b	11	89.7	1.7	29.4	17.5	298	8755
Moderately Susceptible	0.2 a	8	90.3	1.1	31.3	17.5	299	9359
ANOVA p-value	**0.0393**	0.0531	**0.0132**	**0.0036**	0.1803	0.7040	0.8305	0.1445
At-planting treatments[X]								
Untreated control	0.2	10	90.2	1.2	30.8	17.5	299	9219
Systiva	0.3	11	89.9	1.5	29.7	17.5	298	8856
Systiva + Quadris I-F	0.2	9	90.0	1.4	30.3	17.5	298	9056
ANOVA p-value	0.7056	0.7673	0.7725	0.9060	0.1959	0.8933	0.8384	0.4351
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]								
None	0.2	10	90.0	1.4	30.3	17.5	298	9044
4-leaf Quadris	0.2	10	90.0	1.4	30.4	17.5	298	9069
8-leaf Quadris	0.2	10	90.0	1.3	30.5	17.5	299	9115
ANOVA p-value	0.1259	0.2052	0.9213	0.3773	0.4089	0.8024	0.8391	0.5009
LSD (*P* = 0.05)	NS	NS		NS	NS	NS	NS	NS
Vty x At-plant	0.1576	0.3811	0.3979	0.8450	0.2074	0.8491	0.9540	0.3983
Vty x Post	0.2104	0.1825	0.8085	0.7519	0.3821	0.7036	0.9162	0.3126
At-plant x Post	0.1088	0.0331	0.5281	0.2075	0.0732	0.0673	0.1157	0.0340
Vty x At-plant x Post	**0.0238**	0.3939	0.9668	0.0975	0.4165	0.9882	0.9893	0.5402

T Numbers followed by the same letter are not significantly different; LSD = Least Significant Difference, *P* = 0.05; NS = not significantly different

U RCRR = Rhizoctonia crown and root rot; 0-10 scale (adjusted rating), 0 = root clean, no disease, 10 = root completely rotted and plant dead

V RCRR = Rhizoctonia crown and root rot; percent of roots with rating greater than two

W Values represent mean of 36 plots (4 replicate plots across 3 at-planting treatments and 3 postemergence treatments)

X Systiva @ 5 g a.i /unit and Quadris In-furrow @ 9.5 fl oz./A via drip tube; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

Y Quadris Postemergence @ 14.5 fl oz./A in a 7 inch band; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 at-planting treatments)

SMBSC site: Good rainfall during June resulted in moderate disease pressure early in the season (Table 2). Resistant variety had higher stands at 3, 5, and 7 WAP compared to moderately susceptible variety (Fig. 5) but the difference is not statistically significant (Fig. 5). Systiva and Systiva + Quadris I-F had higher stands at 3, 5, and 7 WAP compared to untreated control treatment (Fig. 6). Untreated control had 165 plants/100 ft. row at 7 WAP indicating moderate early season disease pressure at this site and hence Systiva and Systiva + Quadris I-F had 198 and 205 plants/100 ft. row, respectively (Fig. 6). In contrary to 2018 observations (4), Quadris I-F did not reduce stands at this site in 2020 which is very similar to 2019 observation. Some rainfall during July and normal rainfall during August (Table 2) resulted in moderate late season disease pressure at this site. Resistant variety had higher % sucrose and RST and lower root rot severity and incidence compared to the susceptible variety (Table 5). Both 4- and 8-leaf postemergence application resulted in lower root rot severity and incidence, higher % sucrose and RST compared to no postemergence control (Table 5). A significant variety by postemergence treatment interaction was observed for root yield and RSA

(Table 5). Wile both varieties responded to 4- or 8-leaf application, the benefit was higher for the susceptible variety as the genetic resistance to Rhizoctonia is weak in this variety. Both 4- and 8-leaf applications resulted in increase in RSA by about 1700 lbs/A for the resistant variety and about 2800 lbs/A for the susceptible variety (Fig 7). Similar benefit from postemergence Quadris application at this location was also evident in 2016 to 2019 (4-7). Both 4- and 8-leaf applications resulted in increase in root yield by 5 tons/A for the resistant variety and 10 tons/A for the susceptible variety (Fig 8). This trial clearly demonstrates the importance of choosing a resistant variety and use of postemergence fungicides for managing Rhizoctonia diseases in the southern MN growing area.

Table 5. SMBSC site: Main effects of variety, at-planting, and postemergence fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a field trial sown May 14, 2019.

Main effect	RCRR	RCRR %	Yield	Sucrose[T]		
(Apron + Maxim on all seed)	(0-10) [TU]	incidence[TV]	ton A^{-1}[T]	%	lb ton^{-1}	lb A^{-1}
Variety[W]						
Resistant	1.09 a	26 a	30.3	12.2 a	243 a	7414
Moderately Susceptible	1.99 b	41 b	34.0	11.5 b	229 b	7769
ANOVA p-value	<0.0001	0.0004	0.0884	0.0216	0.0231	0.4401
At-planting treatments[X]						
Untreated control	1.54	32	31.3	11.9	238	7509
Systiva	1.80	39	31.7	12.0	234	7478
Systiva + Quadris I-F	1.28	30	32.7	11.8	237	7788
ANOVA p-value	0.1891	0.1580	0.0960	0.8060	0.8028	0.4569
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]						
None	3.1 b	61 c	27.1 b	10.9 b	219 b	5927 b
4-leaf Quadris	1.0 a	25 b	34.3 a	12.2 a	244 a	8348 a
8-leaf Quadris	0.5 a	15 a	34.4 a	12.3 a	247 a	8499 a
ANOVA p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD (*P* = 0.05)	0.5	7.7	1.3	0.5	10	484
Vty x at-plant	0.1870	0.2210	0.4080	0.2770	0.2730	0.2300
Vty x Post	0.3650	0.3090	**0.0003**	0.1540	0.1620	**0.0050**
At-plant x Post	0.9640	0.1990	0.9540	0.8920	0.9040	0.8640
Vty x at-plant x Post	0.9750	0.5460	0.8390	0.3250	0.3580	0.4942

T Numbers followed by the same letter are not significantly different; LSD = Least Significant Difference, *P* = 0.05; NS = not significantly different

U RCRR = Rhizoctonia crown and root rot; 0-10 scale (adjusted rating), 0 = root clean, no disease, 10 = root completely rotted and plant dead

V RCRR = Rhizoctonia crown and root rot; percent of roots with rating greater than two

W Values represent mean of 36 plots (4 replicate plots across 3 at-planting treatments and 3 postemergence treatments)

X Systiva @ 5 g a.i /unit and Quadris In-furrow @ 9.5 fl oz./A via drip tube; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

Y Quadris Postemergence @ 14.5 fl oz./A in a 7 inch band; Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 at-planting treatments)

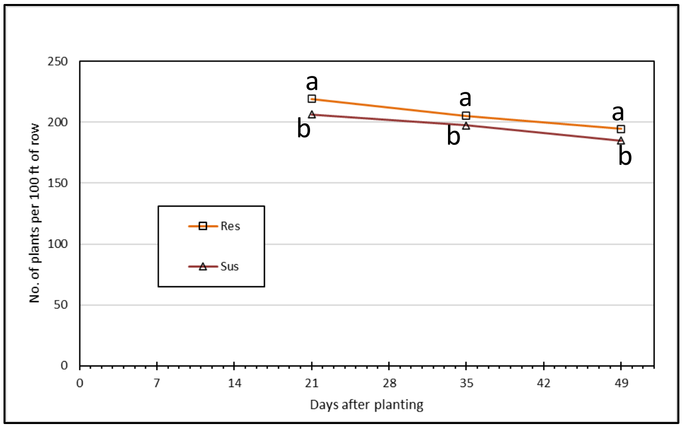

Fig. 5. SMBSC site: Emergence and stand establishment for resistant and moderately susceptible varieties. For each stand count date, values sharing the same letter are not significantly different (*P* = 0.05). Data shown represents mean of 36 plots averaged across at-planting and postemergence treatments.

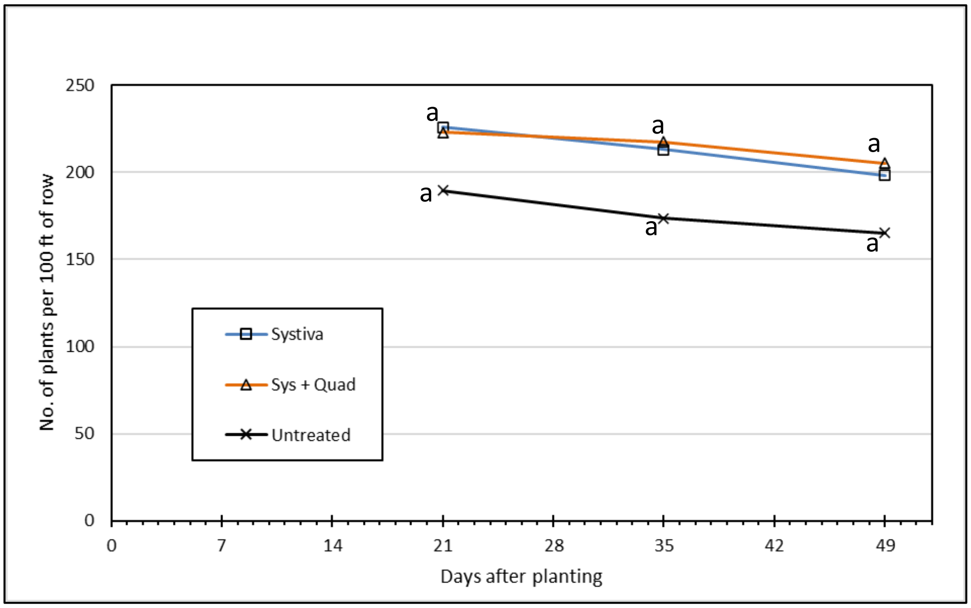

Fig. 6. SMBSC site: Emergence and stand establishment for the at-planting treatments. For each stand count date, values sharing the same letter are not significantly different (*P* = 0.05). Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

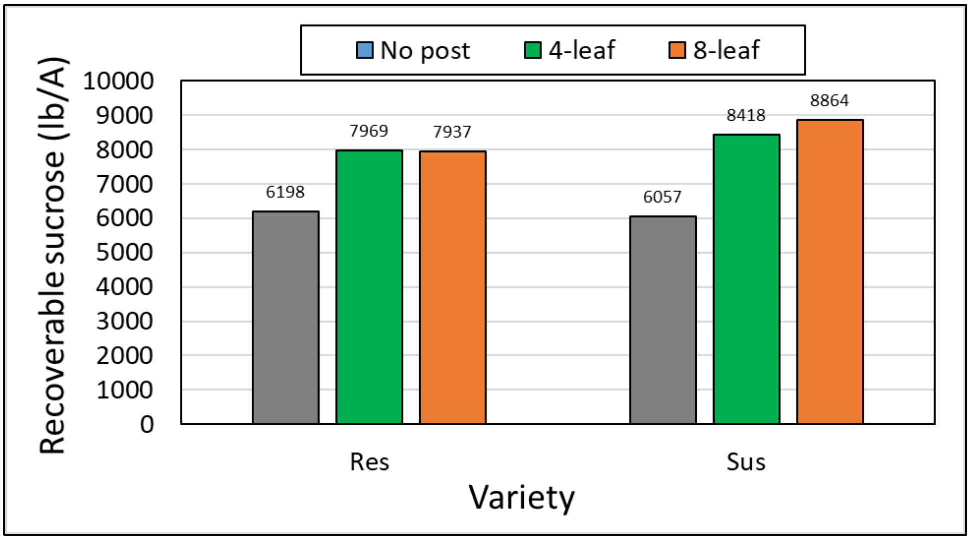

Fig. 7. SMBSC site: Effect of postemergence application on recoverable sucrose. Data shown represents mean of 12 plots averaged across varieties and at-planting treatments.

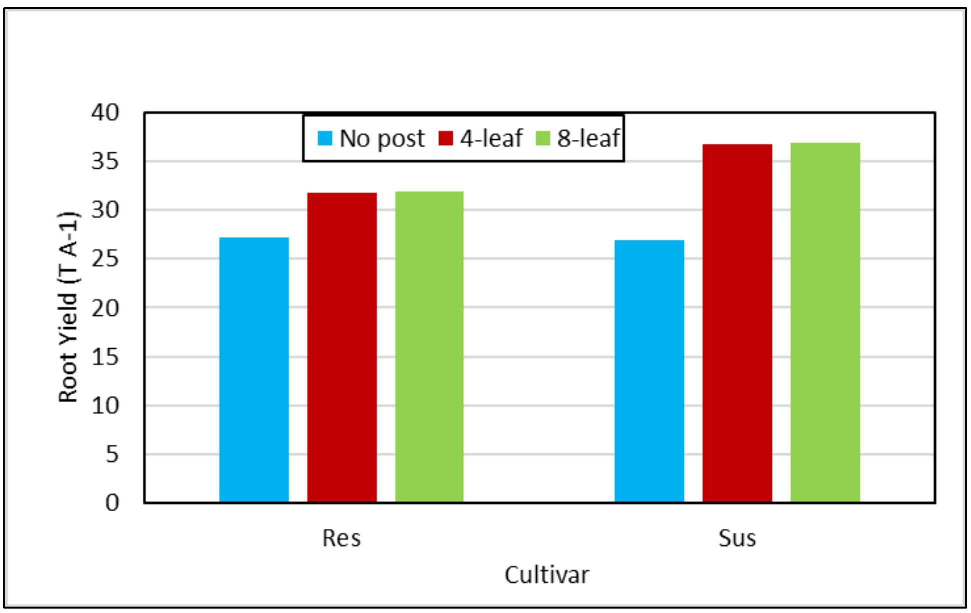

Fig. 8. SMBSC site: Effect of postemergence application on root yield. Data shown represents mean of 12 plots averaged across varieties and at-planting treatments.

ACKNOWLEDGEMENTS

We thank the Sugarbeet Research and Education Board of Minnesota and North Dakota for funding this research; BASF and Syngenta for providing products; Crystal Beet Seed for providing seed; Germains Seed Technology for treating seed; staff from the Minn-Dak Farmers Cooperative for plot maintenance and harvest at the Wahpeton site; staff from the Southern Minnesota Beet Sugar Cooperative for plot maintenance and harvest at the Renville site; the University of Minnesota, Northwest Research and Outreach Center, Crookston for providing land, equipment and other facilities; Jeff Nielsen for plot maintenance; Hal Mickelson, Donny, Anke, and Kenan for technical assistance; Minn-Dak Farmers Cooperative, Wahpeton, ND for the Wahpeton site sugarbeet quality analysis; Southern Minnesota Beet Sugar Cooperative, Renville, MN for the Renville site sugarbeet quality analysis; and American Crystal Sugar Company, East Grand Forks, MN for NWROC site sugarbeet quality analysis.

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Infurrow Product Comparison for Rhizoctonia

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Introduction: Rhizoctonia has a serious economic impact to sugar beet production in Southern Minnesota. Some cultural practices such as tiling and plant genetics have aided in combating this root disease, but in environments that are conducive to rhizoctonia additional tools are needed.

Objective: There are several products available to help control rhizoctonia in addition to the standard seed treatments. Quadris has been the product of choice for both infurrow and post emerge applications in recent years. The objective of this trial is to compare Quadris with other infurrow products available for rhizoctonia control.

Materials and Methods: A trial was conducted near Renville to compare several infurrow rhizoctonia products with and without a post-emerge Quadris application. The trial was planted on May 7th using Beta 9780. Normal agronomic practices were used to keep the trial free of weeds and non-rhizoctonia diseases. This trial was designed as a randomized complete block with four replications and eight treatments. 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 8 leaf Quadris treatments were banded on June 22nd using a bike sprayer with 4001E nozzles with a spray volume of 10.75gpa. The plots were harvested on September 16th 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 tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Results and Discussion: Although none of the parameters tested in this trial were statistically significant for individual treatments, there were some numerical trends in the data (Table 1). Analyzing the data using a linear contrast revealed a statistically significant increase in tons per acre and extractable sugar per acre between the treatments applied at planting compared to the treatments that banded Quadris at the 8-leaf stage in addition to the at planting applications (Table 2). This analysis did not find any statistically significant differences in the quality parameters between the treatments with and without the banded Quadris. The stand counts taken 28 days after planting (DAP) had very few differences and the 8 leaf Quadris treatment had not yet been applied (Table 3). However, the stand counts taken after the plots were defoliated for harvest showed a significantly higher stand for the three treatments that contained a seed treatment, infurrow product, and the 8-leaf banded Quadris compared to the seed treatment alone and the seed treatment plus the 8-leaf banded Quadris. Analyzing the data using a linear contrast showed a statistically significant increase in stand when Quadris was banded at the 8-leaf stage compared to no post application (Table 4).

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Seed Trt Alone	15.4	27.9	12.6	252.3	7028.1	89.0
Seed Trt plus Quadris Infurrow	15.1	29.1	12.5	249.3	7401.4	89.3
Seed Trt plus Xanthion Infurrow	15.0	30.5	12.3	245.5	7416.3	89.1
Seed Trt plus Elatus Infurrow	14.9	29.3	11.5	230.6	6783.1	85.9
Seed Trt Alone / 8 leaf Quadris	15.4	31.6	12.3	246.8	7787.8	87.8
Seed Trt plus Quadris Infurrow / 8 leaf Quadris	15.9	30.8	12.9	257.7	8468.5	88.8
Seed Trt plus Xanthion Infurrow / 8 leaf Quadris	15.2	32.8	12.5	249.7	8142.2	89.2
Seed Trt plus Elatus Infurrow / 8 leaf Quadris	14.4	30.7	11.6	231.6	6821.1	88.3
Mean	15.2	30.4	12.3	245.8	7474.0	88.4
CV%	2.9	9.4	4.2	4.2	9.9	2.0
Pr>F	0.2518	0.3008	0.0875	0.0904	0.1397	0.1811
lsd (0.05)	NS	NS	NS	NS	NS	NS

Table 1: Yield parameter results.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
At Planting Treatments	15.1	29.2	12.2	244.4	7157.2	88.3
At Planting Treatments with 8 leaf Quadris	15.2	31.5	12.3	246.4	7804.9	88.5
Mean	15.2	30.4	12.3	245.8	7474.0	88.4
CV%	2.9	9.4	4.2	4.2	9.9	2.0
Pr>F	0.4315	0.0252	0.5661	0.5730	0.0199	0.9231

Table 2: Yield parameter results between at planting treatments and at planting treatments with Quadris banded at the 8-leaf stage.

Treatment	28 DAP Stand Count per 100' row	PreHarvest Stand Count per 100' row
Seed Trt Alone	185 ab	144 c
Seed Trt plus Quadris Infurrow	200 a	155 bc
Seed Trt plus Xanthion Infurrow	180 ab	159 abc
Seed Trt plus Elatus Infurrow	204 a	162 abc
Seed Trt Alone / 8 leaf Quadris	165 b	154 c
Seed Trt plus Quadris Infurrow / 8 leaf Quadris	180 ab	175 ab
Seed Trt plus Xanthion Infurrow / 8 leaf Quadris	189 ab	173 ab
Seed Trt plus Elatus Infurrow / 8 leaf Quadris	195 a	175 a
Mean	187	162
CV%	8.9	8.2
Pr>F	0.0701	0.0279
lsd (0.05)	24.6	19.5

Table 3: Stand counts taken 28 days after planting and prior to harvest.

Treatment	28 DAP Stand Count per 100' row	PreHarvest Stand Count per 100' row
At Planting Treatments	192	155
At Planting Treatments with 8 leaf Quadris	182	169
Mean	187	162
CV%	8.9	8.2
Pr>F	0.1050	0.0072

Table 4: Stand count results between at planting treatments and at planting treatments with Quadris banded at the 8-leaf stage.

Conclusion: The addition of a banded 8-leaf Quadris application may improve the tons per acre and extractable sugar per acre even if an infurrow product or seed treatment was applied at planting. These treatments also improved plant stand at the end of the season. Some of the infurrow products also had a numerical increase in yield compared to the seed treatment alone. However, additional testing needs to be done to compare individual infurrow products.

Nitrogen Rate Trials for 2020

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[2]Research Agronomist, [3]Research Director, SMBSC, Renville, MN

Justification:

Nitrogen management is a top priority for production of high-quality sugar beet. With the continued changes in sugar beet production, 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 2020, two locations in the Southern Minnesota Beet Sugar Cooperatives growing area had studies that had a N fertilizer rate component to them. One location near Wood Lake and the other near Blomkest. 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, 30 and 43 lb N/A. The N fertilizer rates at the Wood Lake location were 0, 30, 60, 90, 120, 150, 180, and 210 lb N/A and 0, 20, 50, 80, 110, and 140 lb N/A at the Blomkest location. The Wood Lake location had 12 replications of the N rates and the Blomkest location had six. The fertilizer N source was urea applied 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 Wood Lake and Blomkest locations in 2020.

Soil test	Wood Lake	Blomkest
Soil nitrate-N 0-4 ft. (lb N/A)	30	43
Olsen -P 0-6 in. (ppm)	69	18
K 0-6 in. (ppm)	274	194
pH 0-6 in. (unitless)	7.5	7.4
Organic matter 0-6 in. (%)	4.5	5.4

Results:

The 2020 growing season was significantly better than 2018 and 2019. The average root yield was 35 tons/A and the average sucrose was 18 % at the Wood Lake location and 41.1 tons/A and 17.9 % at the Blomkest location.

Wood Lake:

The addition of N fertilizer significantly affected root yield, extractable sucrose per ton, and extractable sucrose per acre at the Wood Lake location in 2020, Table 2 and Figures 1, 2, and 3. The response was linear for all variables. The soil test nitrate-N was low and a positive response for root yield and extractable sucrose per acre was expected. The positive response of root yield and extractable sucrose per acre maximized at the top N rate applied. This rate was 210 lb N/Acre of fertilizer with a soil test nitrate-N plus fertilizer N of 240. This is greater than the current guideline. Also unexpected was the increase in extractable sucrose per ton with N application. While the increase was small, normally the application of N fertilizer reduces extractable sucrose per ton.

Table 2. The effect of nitrogen on root yield, extractable sucrose per ton, and extractable sucrose per acre at the Wood Lake location in 2020. (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
30	0	28.6	296	8477
60	30	30.3	296	9034
90	60	34.4	293	10342
120	90	34.1	299	10117
150	120	37.6	293	10973
180	150	36.0	303	10938
210	180	38.5	305	11747
240	210	40.9	297	12116
Statistics	N rate	0.0001	0.04	0.0001
	C.V.	7.4	3.2	8.4
	Mean	35.1	298	10429

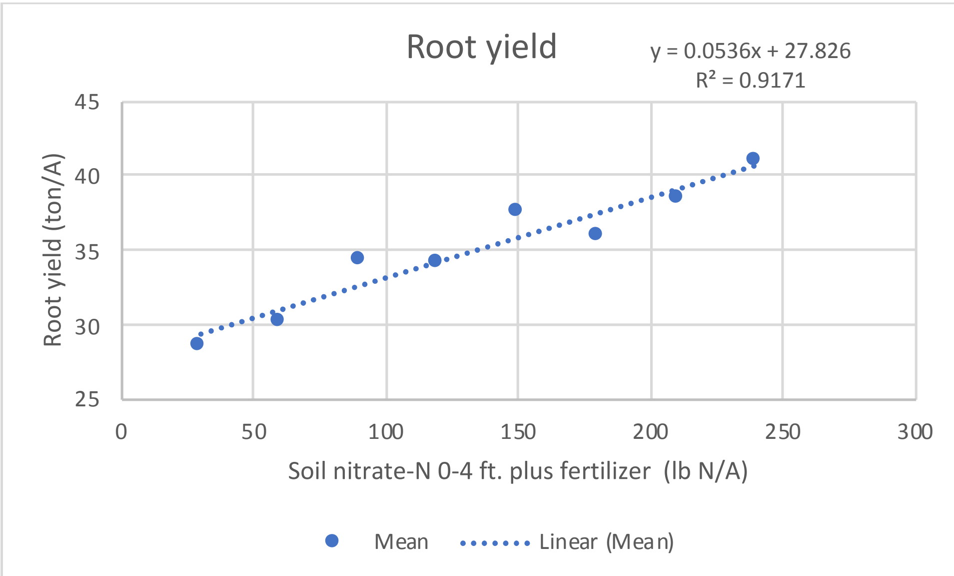

Figure 1. The effect of soil nitrate-N plus fertilizer N on root yield at the Wood Lake location in 2020. (Data provided by Dan Kaiser U of MN).

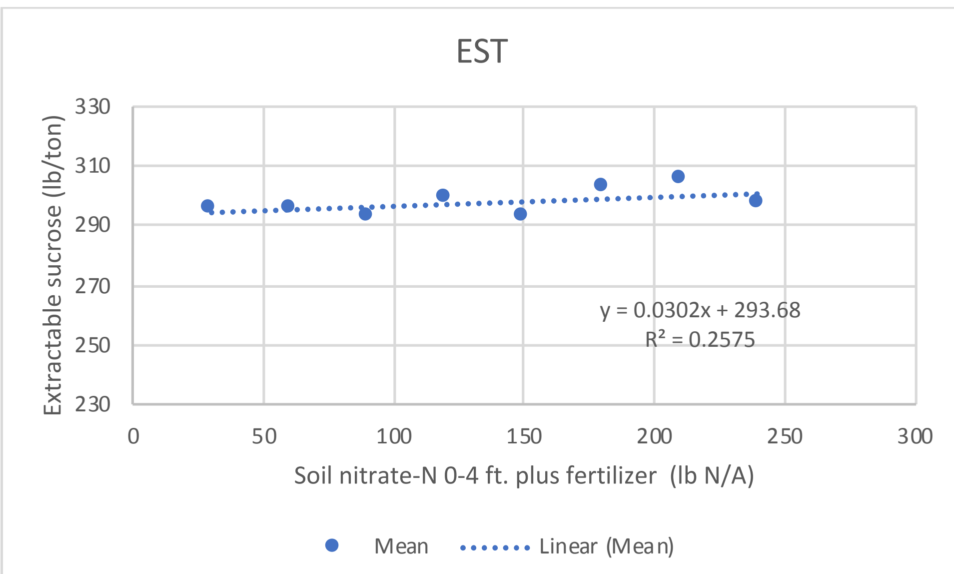

Figure 2. The effect of soil nitrate-N plus fertilizer N on extractable sucrose per ton at the Wood Lake location in 2020. (Data provided by Dan Kaiser U of MN).

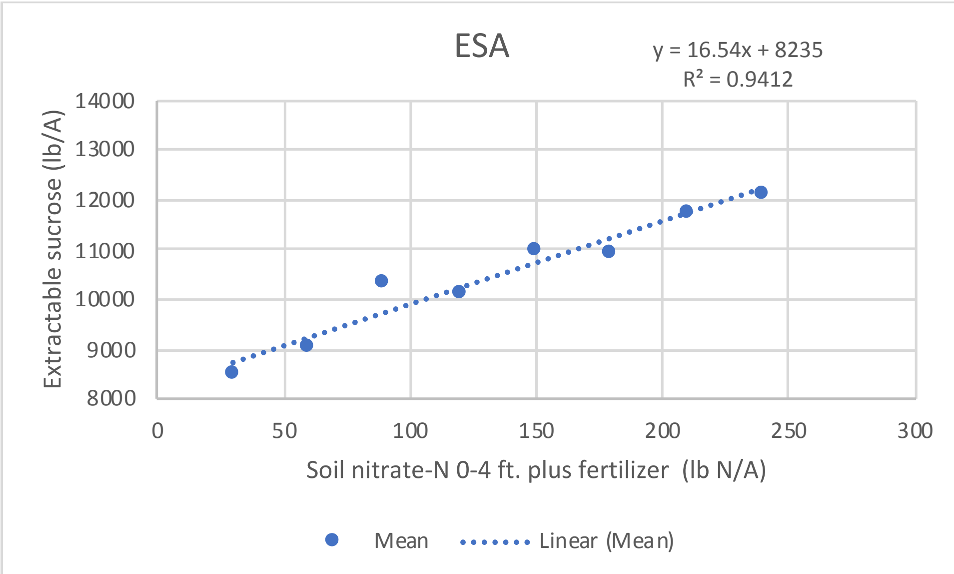

Figure 3. The effect of soil nitrate-N plus fertilizer N on extractable sucrose per acre at the Wood Lake location in 2020. (Data provided by Dan Kaiser U of MN).

Blomkest:

The addition of N fertilizer at the Blomkest location did not significantly affect the root yield or the extractable sucrose per acre, Table 3, Figures 4, 5, and 6. This was not expected as the soil test nitrate-N to a depth of four feet was low at 43 lb N/A. Root yield and extractable sucrose per acre were very good, 40.3 tons/A and 12,402 lb/A with no fertilizer N applied. The extractable sucrose per acre was increased slightly by the addition of fertilizer N.

Table 3. The effect of nitrogen on root yield, extractable sucrose per ton, and extractable sucrose per acre at the Blomkest location in 2020.

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
43	0	40.3	300	12402
63	20	42.3	297	12576
93	50	41.5	305	12648
123	80	42.1	305	12833
153	110	40.7	315	12818
183	140	39.6	308	12188
Statistics	N rate	0.19	0.03	0.52
	C.V.	5.0	2.8	5.4
	Mean	41.1	305	12600

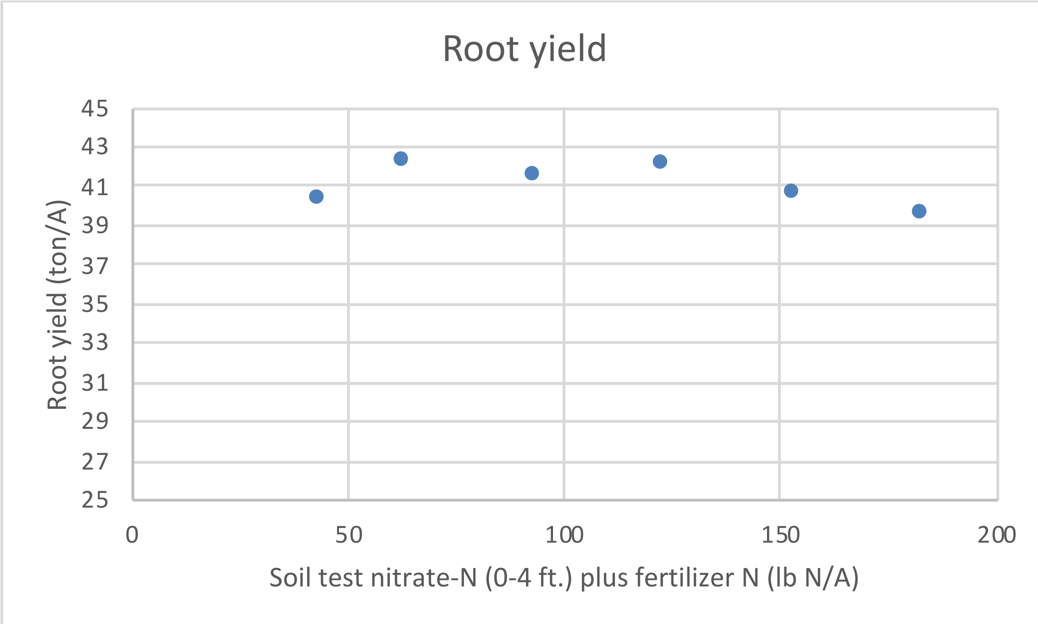

Figure 4. The effect of soil nitrate-N plus fertilizer N on root yield at the Blomkest location in 2020.

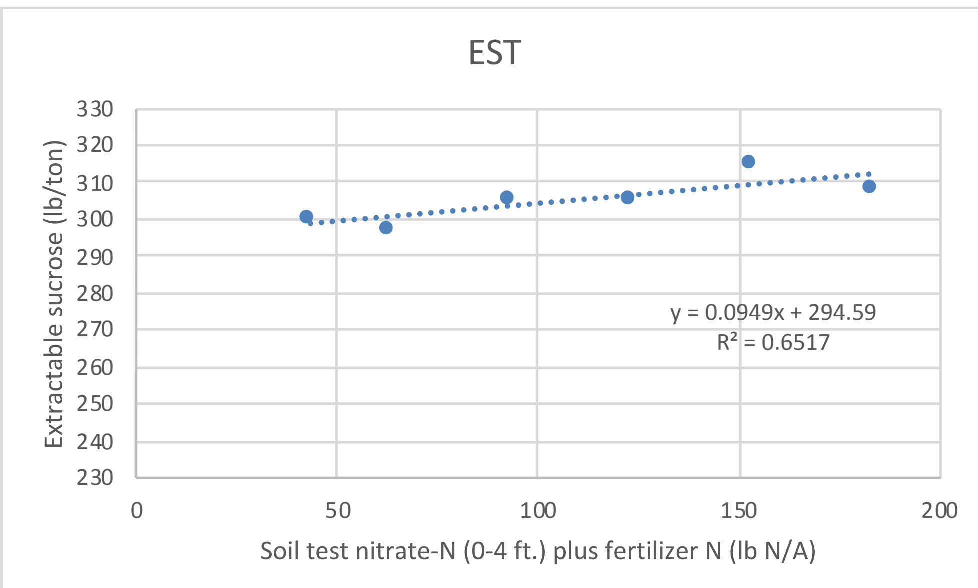

Figure 5. The effect of soil nitrate-N plus fertilizer N on extractable sucrose per ton at the Blomkest location in 2020.

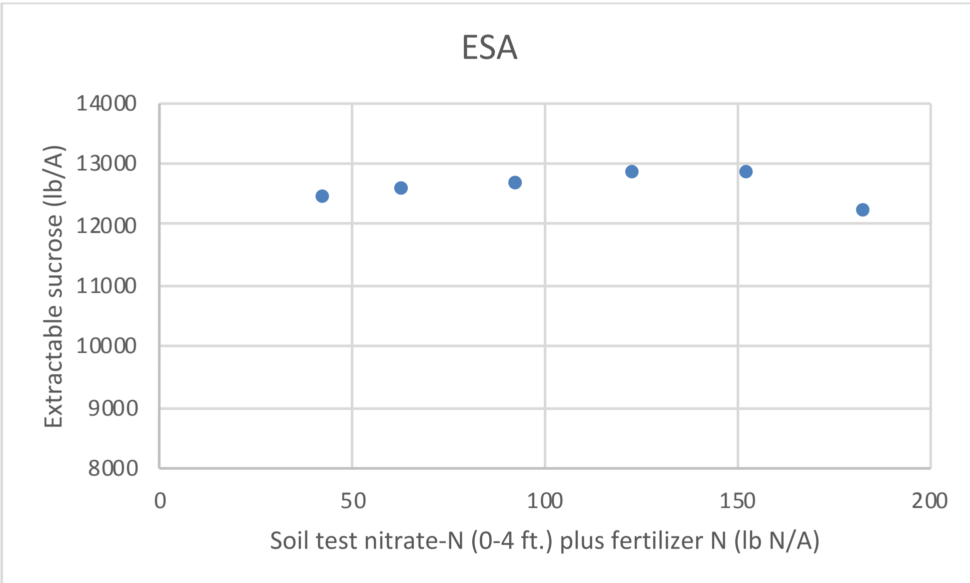

Figure 6. The effect of soil nitrate-N plus fertilizer N on extractable sucrose per acre at the Blomkest location in 2020.

Summary:

The responses to N application were not as expected for root yield, extractable sucrose per ton, and extractable sucrose per acre at either location in 2020. With the low soil test nitrate-N, we expected the application of N fertilizer to increase the root yield and extractable sucrose per acre at both locations. At Wood Lake, both of these parameters increased but did not maximum at the greater N rates. At the Blomkest location, we did not get a response to N fertilizer even though the soil test nitrate-N was low. Why did this happen? There was a difference in organic matter between the locations of about 0.9 %. While that could explain some of the difference, it does not explain it all. Another difference between these two sites was the previous crop. The Wood Lake site followed field corn while the Blomkest site followed soybean. The difference in the amount of plant residue from the previous crop may have impacted the amount of nitrogen available at these two locations. The small increase in extractable sucrose per ton was also not expected nor is it explainable.

What does this mean for the N fertilizer guideline currently used? This guideline is based on many locations of data and because the information for the Wood Lake site had a positive response, it will be added to that information. Current guidelines based on research from 2010 to 2020 indicate that the optimum extractable sucrose per acre can be achieved with 123 lb N/A as soil test nitrate-N to a depth of four feet plus fertilizer N.

Split Nitrogen Applications in Southern Minnesota 2020 – non-irrigated heavy textured soils.

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[2]Research Agronomist, [3]Research Director, SMBSC, Renville, MN

Introduction and Objective:

Producing sucrose in Minnesota requires growers to optimize their N application for increasing root yield with the decreasing effect of N application on sucrose concentration and purity. The optimum N rate has been the topic of many research studies with the N fertilizer being applied pre-plant. There has been interest in splitting the N application between pre-plant and sometime during the growing season to “spoon feed” the sugar beet root for optimum root yield while not having negative effects on sucrose concentration and purity. The objective of this study was to determine if split applications of N fertilizer can improve root yield without decreasing root quality. The sub-objectives were A: to conduct an N rate study to supply more information for the N fertilizer recommendations and also determine if the site was responsive to N application and B: to determine if a split N application was superior to a pre-plant or an in-season application.

Methods and Materials:

To meet the objectives, a study was conducted during the 2020 growing season at one location within the Southern Minnesota Beet Sugar Cooperative growing area. The initial soil test values are reported in Table 1. Ten treatments, Table 2, were established. Treatments 1 through 6 were used to determine the response to N application while treatments 3, 4, 7, 8, 9, and 10 were used to compare N application timing responses. The experiment was a randomized complete block design with six replications. The plots were six – 22 inch rows wide and 35 ft. long. The pre-plant N applications were broadcast treatments of urea (46-0-0). The urea was incorporated immediately after application. The in-season N applications were injected between the sugar beet rows as liquid urea ammonium nitrate solution (32-0-0). The Blomkest location was planted on April 25, 2020 to SES 863 and the in-season N application occurred on May 26, 2020. This site was harvested on October 14, 2020. The previous crop was soybean.

Table 1. Soil test information for 2020 in-season N location.

Soil test and depth	Blomkest
Nitrate-N (lb/A) 0-48 inches	43
Olsen P (ppm) 0-6 inches	18
Soil test K (ppm) 0-6 inches	194
pH (unitless) 0-6 inches	7.4
Organic matter (%) 0-6 inches	5.4

Table 2. Treatments for N application study at Blomkest location, 2020.

Treatment number	Total N applied (ST* + Fertilizer)	Preplant*	Split
	-------------------- lb N/acre --------------------		
1	43	0	0
2	63	ST+20	0
3	93	ST+50	0
4	123	ST+80	0
5	153	ST+110	0
6	183	ST+140	0
7	93	25	25
8	123	40	40
9	93	0	50
10	123	0	80

*ST = Soil test nitrate-N to a depth of four ft.

The treatments were based on the nitrate-N soil test taken to a depth of 4 feet. The soil test was 43 lb N/A in the 0-4 ft depth.

Results and Discussion:

This study was analyzed as a randomized complete block design. With this analysis, the response to pre-plant N application and the effect of different methods of application was evaluated. The conditions for growth in 2020 were very good. The root yield and extractable sucrose per acre for the check plot was 40.3 tons per acre and 12,354 lbs sucrose per acre.

Nitrogen fertilizer response:

Of the measured parameters, nitrogen fertilizer application affected extractable sucrose per ton, Table 3. Root yield, purity, and extractable sucrose per acre were not affected by N application.

Extractable sucrose per ton: Extractable sucrose per ton was affected by N application, Table 3. The N response was linear with a maximum extractable sucrose at the 183 lb N per acre, soil test nitrate-N plus fertilizer N applied, Figure 1. This response to N fertilizer was not maximized.

Nitrogen fertilizer and timing:

Three different application methods and timings at two N fertilizer rates were applied in 2020. The treatments were N application at pre-plant, at side-dressing and half the N applied at pre-plant and half at side-dressing. The N rates used were 50 and 80 lb N/A. These treatments did not affect any of the measured parameters; root yield, purity, extractable sucrose per ton, or extractable sucrose per acre Table 3. The split treatment root yield, purity, extractable sucrose per ton, and extractable sucrose per acre where not different from the check.

Table 3. Root yield, purity, extractable sucrose per ton, and extractable sucrose per acre for all treatments in 2020 at the Blomkest location, LSMEANS.

N rate (lb N/A)		Total N*	Root yield	Purity	Extractable sucrose	
Pre-plant	In-season	lb N/A	ton/A	%	lb/ton	lb/A
0	0	43	40.3	90.7	299	12354
20	0	63	42.3	90.7	297	12576
50	0	93	41.5	91.2	305	12648
80	0	123	42.1	91.3	305	12833
110	0	153	40.7	91.3	315	12818
140	0	183	39.4	91.0	308	12138
25	25	93	42.3	91.4	305	12907
40	40	123	41.7	90.6	298	12423
0	50	93	42.4	90.4	293	12405
0	80	123	40.8	90.8	301	12307
Grand mean			41.4	90.9	303	12562
			Statistical Analysis			
Treatment			0.29	0.17	0.004	0.52
N rate			0.19	0.52	0.03	0.52
Check vs Split trts			0.16	0.43	0.54	0.49
C.V. (%)			5.0	0.7	2.7	5.1

*Total N is the amount of nitrate-N in soil to four feet plus fertilizer applied.

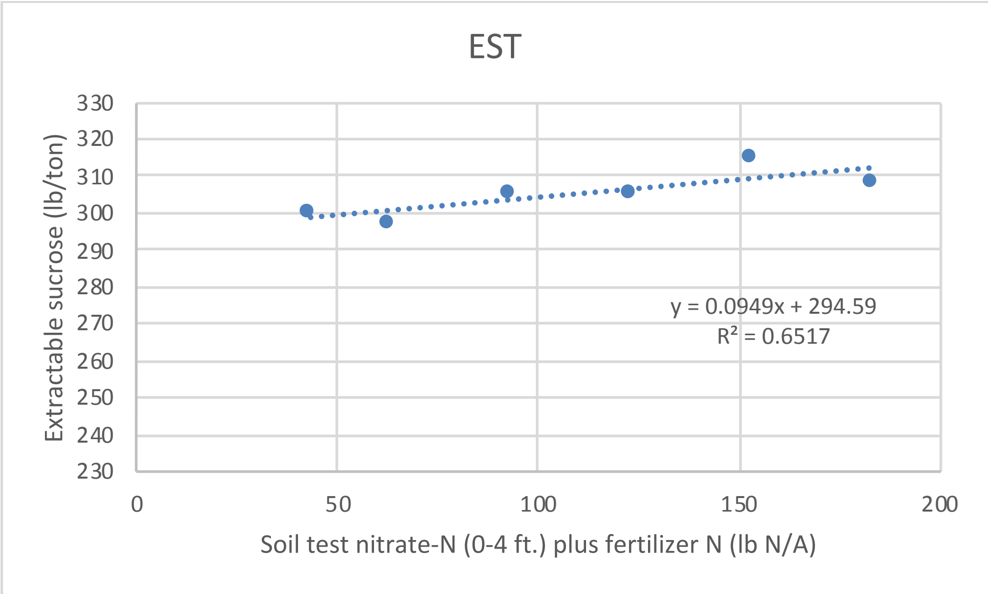

Figure 1. The effect of soil nitrate-N plus fertilizer N on extractable sucrose per ton at the Blomkest location in 2020.

Summary:

In 2020, weather conditions were near ideal for sugar beet production. Even with a low soil test nitrate-N, root yield, purity, and extractable sucrose per acre did not respond to the addition of N fertilizer. Extractable sucrose per ton was increased with increasing N application. Because of the lack of response to N application for root yield, purity, and extractable sucrose per acre, the time of N application did not affect those parameters. Even though extractable sucrose per ton was affected by N application, the split treatments did not significantly affect extractable sucrose per ton. The evaluation of this information would indicate that the use of split applications of N fertilizer did not help or hurt sugar beet production at this location in 2020.

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

Daniel Kaiser[1], Mark Bloomquist[2], and David Mettler[2]

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[2]/Southern Minnesota Beet Sugar Cooperative, Renville, MN

Justification: Research on biostimulant use in sugar beet production is not widespread. The number of biostimulant products marketed has increased recently. However, there is little information as to potential yield or quality benefits for beneficial microbes or chitosans in sugar beet production in the U.S.

Objectives:

1. Evaluate nitrogen fertilizer requirement for sugar beet.

2. Determine whether a biostimulant such as chitosans or beneficial N fixing bacteria can increase sugar beet yield and reduce the amount of N required to maximize root yield and recoverable sugar per acre.

Table 1. Location, planting and sampling information and dominant soil series at Wood Lake in 2020.

Date of				Soil		
Urea App.	Planting	Tissue Sampling	Harvest	Series	Texture†	Classification‡
22-Apr.	22-Apr.	9-Jul.	5-Oct.	Canisteo	CL	T. Endoaquoll

† CL, clay loam.
‡ T, typic

Materials and Methods: A single field trial was established near Wood Lake (Table 1) using a strip plot design. Main blocks consisted of six rates of N (0, 30, 60, 90, 120, 150, 180, and 210 lbs of N) applied as spring urea. The biostimulant treatments were applied in-furrow across the N rates as strips randomized within each replication. Biostimulant treatments included none, High Tide [chitosan additive manufactured by Tidal Vision and applied at 75 mL/ac (30 mL/gallon of starter)], and a mixture of 60 oz/ac of Bio Red plus 22.5 oz/ac of Bio Mate. Bio Red and Bio Mate contain Azotobacter, Clostridium, and Lactobacillus bacteria which are nitrogen fixing bacteria, plus sugar which acts as a food source for the bacteria. Bio Red and Bio Mate were sourced locally through a Biovante distributor at Grand Meadow, MN and High Tide was sourced through Amazon.com. All biostimulant treatments were mixed with deionized water and the mix was combined 1:1 v/v with 3 gallons per acre of 6-24-6. The combined solution starter/biostimulant mixture was applied at a rate of 6 GPA. The no biostimulant control included 6-24-6 and deionized water only.

Soil samples were collected at 0-6, 6-24, and 24-48" as a single composite sample from the trial area. Initial soil test information is summarized in Table 2. Leaf blade and petiole samples were collected in early July (Table 1) by sampling the uppermost fully developed leaf. Extractable nitrate-N was determined following extraction with 2% acetic acid. Petiole and leaf blade samples were analyzed for total N dry combustion.

Table 2. Summary of 2020 spring pre-plant soil test results.

	0-6" Soil Test				Soil Test Nitrate-N	
Location	Olsen P	Ammonium Acetate K	pH	SOM	0-2'	2-4'
	----------ppm----------			----%----	-------lb/ac-------	
Wood Lake	69	274	7.5	4.5	22	8

Plots were harvested at the end of the growing season and root samples were analyzed for quality parameters. The variety planted was SV 863 at Wood Lake planted at 252 plants per 100 foot of row (59,800 plants per acre). All practices, weed and disease control, planting, and tillage were consistent with common practices for the growing region (a summary of relevant application and sampling data are given in Table 1).

Summary

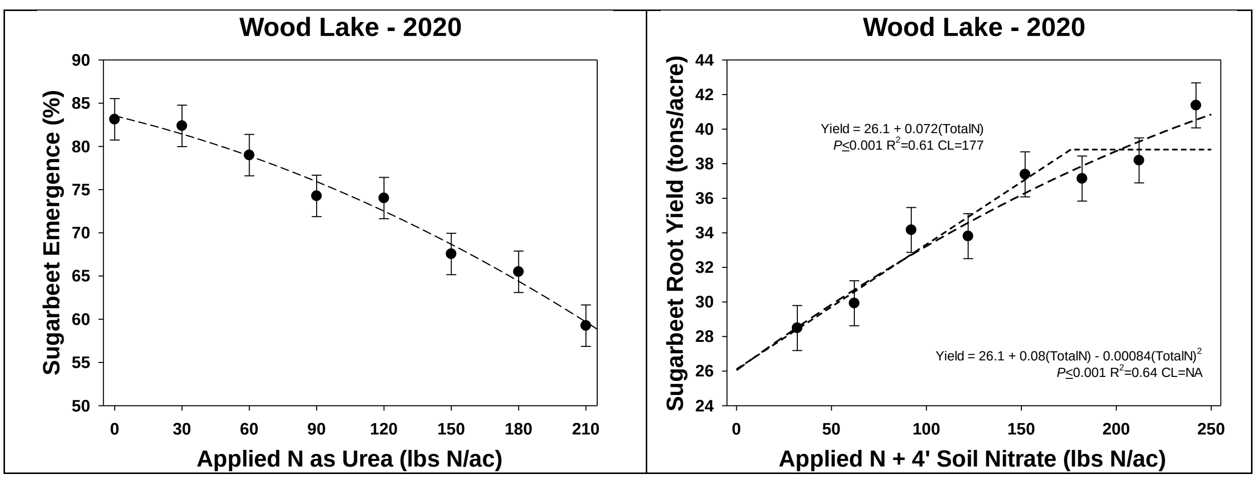

Figure 1. Effect of nitrogen applied as spring urea on sugar beet emergence and root yield at Wood Lake, MN during the 2020 growing season.

Sugar beet emergence was decreased with increasing rate of spring urea (Figure 1). In contrast root yield was increased, and never was decreased, by the addition of nitrogen. Root yield was increased by 40% with the greatest rate of nitrogen applied, which also resulted in a 20% reduction in yield. While emergence was reduced the sugar beet plants were able to compensate for the reduction in stand by increasing root size. The optimal rate of nitrogen needed to maximize root yield was between 177 and 250 lbs of nitrogen as a combination of urea-nitrogen and the amount of nitrate-nitrogen in a four-foot soil sample.

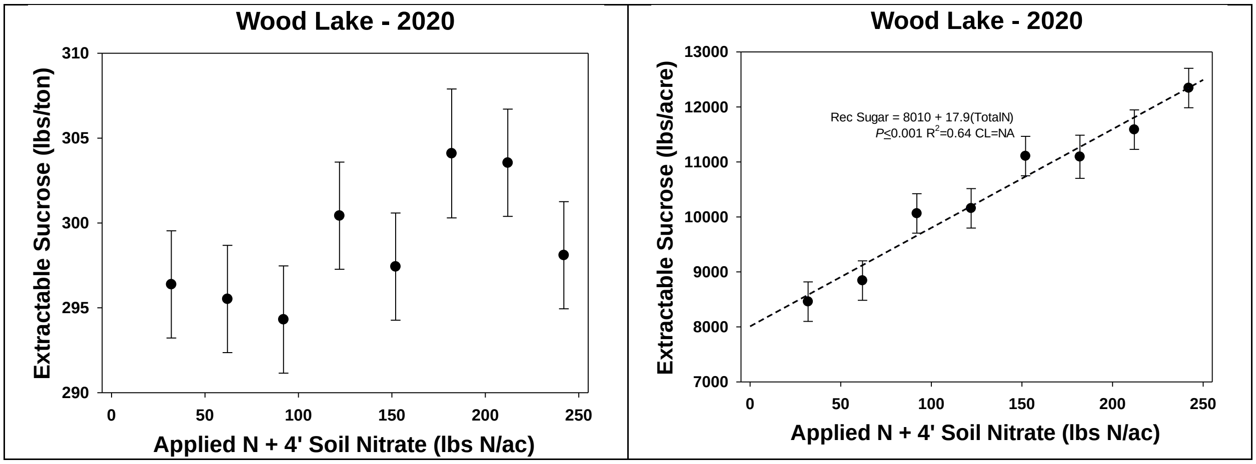

Figure 2. Effect of nitrogen applied as spring urea plus the nitrate in a four-foot on sugar beet extractable sucrose per ton and extractable sucrose per acre at Wood Lake during the 2020 growing season.

Recoverable sucrose per ton was not impacted by the amount of nitrogen applied plus the amount of nitrate-nitrogen in a four-foot soil sample (Figure 2). Recoverable sucrose per acre continued to increase past the highest rate of nitrogen applied.

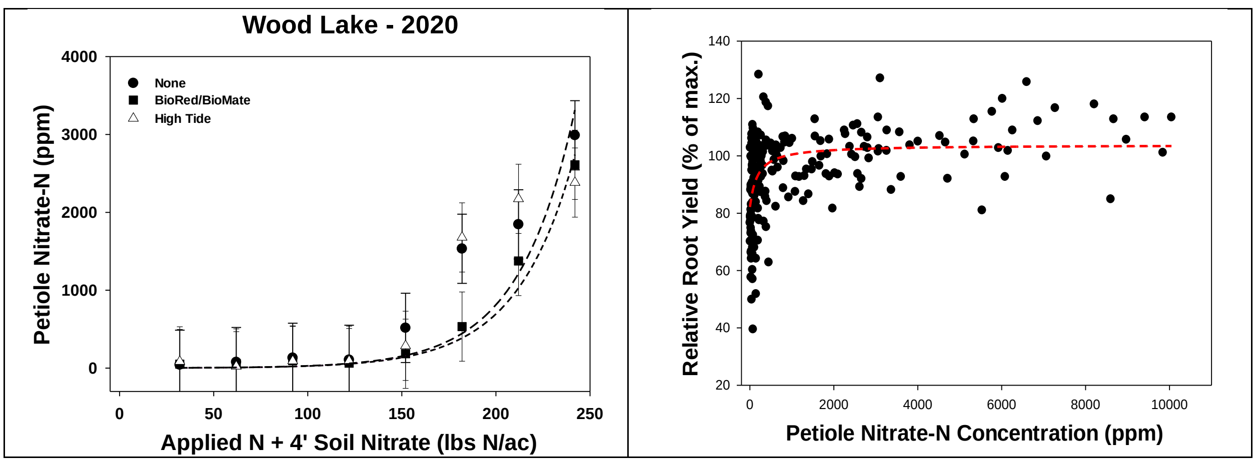

Figure 3. Effect of nitrogen applied as spring urea plus the nitrate in a four-foot on sugar beet early to mid-July petiole nitrate measured from the newest fully developed leaf at Wood Lake in 2020 and a summary of relative root yield versus petiole nitrate-N concentration collected over three field locations at Wood Lake, Lake Lillian, and Crookston, MN in 2020.

Mid-July petiole nitrate concentration were relatively low at the Wood Lake site (Figure 3) and only increased when the amount of nitrogen applied plus the four-foot nitrate-nitrogen was greater than 150 lbs. Root yield was on average at 100% maximum potential when petiole nitrate-nitrogen concentration was 850 ppm or greater. However, root yield ranged from 50-100% of maximum when petiole nitrate-nitrogen concentration was less than 850 ppm. More data are needed to better calibrate the petiole nitrate-nitrogen test in medium or fine textured rain-fed soils.

Table 3. Summary of the main effect of in-furrow biostimulant source for selected variable at Wood Lake, MN in 2020. Letters indicating least significant difference are only listed in the table when the main effect of biostimulant was significant.

Biostimulant	Emergence	Petiole N	Yield	Rec. Suc. (ton)	Rec Suc. (acre)
	-----%-----	----ppm----	-tons/ac-	--lb/ton--	---lb/ac---
None	72	905a	35.9	299ab	10670
BioRed/Mate	75	621b	34.6	295b	10227
High Tide	72	852a	34.7	301a	10474

†Numbers followed by the same letter are not significantly different at the $P \leq 0.10$ probability level.
Suc., sucrose.

The use of biostimulants did not affect sugar beet emergence, root yield, and recoverable sucrose estimated on a per acre basis (Table 3). Petiole nitrate-nitrogen and recoverable sucrose per ton were affected by biostimulants. However, biostimulants did not provide a positive benefit to any measured parameter, and sometimes had negative impacts on measured parameters.

Conclusions

The response to nitrogen was greater than expected at the Wood Lake location. The nitrogen response data will be added to the ongoing collection of additional nitrogen rate response data for sugar beet in the southern Minnesota growing area. Biostimulants did not provide any measurable benefit for sugar beet production at one location in 2020. More data would be required to determine the exact probability of response. Growers should be cautioned against substituting biostimulants for standard fertilizer practices until research data can be generated showing a clear benefit to products in reducing the amount of N needed or any additional positive benefits.

Acknowledgments

The authors would like to thank the research crews at the Southern Minnesota Beet Sugar Cooperative and the Department of Soil, Water, and Climate Field Crew. I would also like to thank both Southern Minnesota Beet Sugar Cooperative for providing the quality analysis for this research and the Sugar beet Research and Education Board of Minnesota and North Dakota for providing funding for this project.

Soil Fertility for Corn Grown after Unharvested Sugar Beets

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[2]Research Agronomist, [3]Research Director, SMBSC, Renville, MN

Justification: 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 near the SMBSC Murdock piling site on field corn grown in 2020 to answer the objective. This site was planted to sugar beets in 2019 and the beets were defoliated but not harvested except for selective treatments. The study included the treatments listed in Table 1. The experimental design was a randomize 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. The corn was machine harvested on November 4, 2020.

Treatment	2019 Beets	Starter	N rate
1.	Not harvested	none	0
2.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0
3.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended – 40 lb N/A (115 lb N/A)
4.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)
5.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended + 40 lb N/A (195 lb N/A)
6.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended +80 N/A (235 lb N/A)
7.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)
8.	Harvested	None	0
9.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0

Results: 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 non-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. Additional years of data is needed to devise a solid recommendation.

Table 2. Corn grain yield and statistical analysis for 2020.

Treatment	Beets	Starter	N rate	Grain yield (bu/A)
1.	Not harvested	none	0	107
2.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0	126
3.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended – 40 lb N/A (115 lb N/A)	224
4.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)	234
5.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended + 40 lb N/A (195 lb N/A)	255
6.	Not harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended +80 N/A (235 lb N/A)	241
7.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	Recommended (155 lb N/A)	251
8.	Harvested	None	0	150
9.	Harvested	7 gallons 10-34-0 plus 1 lb Zn/acre	0	160
$LSD_{0.05}$				21
Grand mean				196
Trt				0.0001
Harvest vs No harvest				0.0001
Starter vs No starter				0.07
0 N vs Recommended				0.0001
C.V. %				7.2

Table 3. Corn grain yield means for direct comparisons of Non-Harvested and Harvested sugar beet, use of starter fertilizer, and use of Recommended N fertilizer in 2020.

Comparison	Corn grain yield 15.5 % (bu/A)
Not Harvested	156 bu/A
Harvested	187 bu/A
No Starter	129 bu/A
Starter	143 bu/A
No N	143 bu/A
Recommended N	243 bu/A

Mineralization Trial

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

Introduction: The sugar content and purity of a beet crop is a major factor in how well 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 with above average rainfall. The high organic matter of the soils in the SMBSC growing area can mineralize large amounts of nitrate nitrogen during periods of warm, wet weather. Late season nitrogen mineralization can reduce the sugar content of sugar beets. If the mineralization process could be reduced that could potentially increase the sugar content of the beet crop.

Objective: Low sugar content has hindered the SMBSC beet payment in recent years. Novel approaches to test the reduction of late season mineralization may improve the sugar content of the beet crop.

Materials and Methods: In 2019 this experiment was located west of the Redwood Falls piling site. The entire site was planted on May 16th using Crystal M623 with three gpa of 6-24-6 starter fertilizer. In 2020 this experiment was located east of Lake Lillian and planted on April 27th using SV863. Normal agronomic practices were used to keep the sites weed and disease free. Four treatments were set up in a randomized complete block design with four replications (Table 1). These treatments were applied to the center three inter rows of six row plots and were tested for the ability to tie up nitrate nitrogen. The rye treatment was seeded on July 19th in 2019 and on June 16th in 2020 by hand and then incorporated with a row crop cultivator. Before the sawdust and sugar treatments were applied on August 15th in 2019 and on August 20th in 2020, a one foot soil sample was taken and after application soil samples were taken every two weeks until harvest. The sawdust and sugar were also incorporated using a row crop cultivator. The center two rows of each six row plot were harvested on September 19th in 2019 and on September 21st in 2020 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 tare lab. The soil sample dates were all analyzed separately. The soil sample analysis and yield quality analysis were performed using SAS GLM version 9.4.

Treatment	Application Rate Per Acre	Application Rate Per Plot
Control	N/A	N/A
Sugar	31403lbs	138.8lbs
Sawdust	10130lbs	44.8lbs
Rye	20 lbs	40g

Table 1: Treatments and product amount.

Results: There were no significant differences in the amount of ammonium across any of the sampling periods in either year (Table 2 and 3). Before the treatments were applied there were not significant differences in the amount of nitrate. However, in the second and third sample the Sugar treatment had a significantly lower amount of nitrate than the other treatments in both years. A combined analysis found a significant difference in the percent sugar but not in any other yield or quality parameters (Table 4). The Sugar treatment had a significantly higher percent sugar than all of the other treatments. This increase in percent sugar may be linked with the reduction in soil nitrate in the Sugar treatment.

	First Sample		Second Sample		Third Sample	
	Nitrate	Ammonium	Nitrate	Ammonium	Nitrate	Ammonium
Control	14.0	6.3	12.0 a	6.5	10.5 a	5.8
Sugar	12.0	6.0	4.0 b	6.0	4.5 b	6.0
Sawdust	13.5	7.3	11.5 a	7.0	12.0 a	6.0
Cereal Rye	13.0	7.3	10.0 a	7.3	10.5 a	6.0
Mean	13.1	6.7	9.4	6.7	9.4	5.9
CV%	20.0	15.4	16.0	16.9	18.9	21.4
Pr>F	0.7420	0.2509	0.0001	0.4539	0.0010	0.9892
lsd (.05)	NS	NS	2.4	NS	2.8	NS

Table 2: Nitrate nitrogen and ammonium nitrogen in one foot soil samples in pounds per acre at the 2019 site.

	First Sample		Second Sample		Third Sample	
	Nitrate	Ammonium	Nitrate	Ammonium	Nitrate	Ammonium
Control	10.0	14.5	9.0 ab	15.3	10.0 a	10.8
Sugar	9.5	15.5	4.0 c	15.8	4.0 b	12.8
Sawdust	9.5	14.8	7.5 b	16.8	11.5 a	11.3
Cereal Rye	8.5	16.8	9.5 a	14.0	10.0 a	10.8
Mean	9.3	15.2	7.8	15.6	9.2	11.8
CV%	14.6	10.5	15.0	11.4	13.0	13.3
Pr>F	0.6011	0.2316	0.0001	0.2929	<.0001	0.1231
lsd (.05)	NS	NS	1.8	NS	1.8	NS

Table 3: Nitrate nitrogen and ammonium nitrogen in one foot soil samples in pounds per acre at the 2020 site.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Control	16.0 a	26.9	13.7	273.4	7359.2	91.5
Sugar	16.7 b	26.4	14.1	283.0	7602.6	90.9
Sawdust	16.2 a	26.3	13.7	274.7	7220.6	91.2
Cereal Rye	16.1 a	26.6	13.8	275.4	7301.8	91.6
Mean	16.2	26.5	13.8	276.1	7396.4	91.3
CV%	1.9	5.9	3.4	3.4	5.1	1.6
Pr>F	0.0339	0.8889	0.2530	0.2530	0.7862	0.7904
lsd (0.05)	0.28	NS	NS	NS	NS	NS

Table 4: Yield parameter results for the Mineralization Trial.

Conclusion: Based on these results it would appear that it is possible to slow late season mineralization and increase percent sugar in the beet crop. However, the treatment that reduced the amount of soil nitrate is neither practical or economical. With some data showing that it is possible to reduce late season mineralization more research needs to be done to find an economical way of reducing nitrate nitrogen and increasing percent sugar.

Sugar Enhancement Trial

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

Introduction: The sugar content and purity of a beet crop is a major factor in how well 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 Lake Lillian to screen several products that may have the ability to improve sugar content. The trial was planted on April 27th 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 eight treatments. 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 6-8 leaf treatments were applied on June 5th using a bike sprayer with XR11002 nozzles with a spray volume of 17gpa. The 10-12 leaf treatments were applied on June 20th using the same sprayer equipment. The center two rows of each six row plot were harvested on September 20th 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 tare lab. The data was analyzed for significance using SAS GLM version 9.4.

Results and Discussion: No significant differences were found in the yield parameters (Table 1). None of the products tested performed statistically better than the control. 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	Treatment Description	Timing
1	Control	N/A
2	Sugar and Spice (1gal/acre)	6-8 leaf and 10-12 leaf
3	FP16 (2gal/acre)	6-8 leaf and 10-12 leaf
4	Nresponse + Micro 500 (1gal/acre)	6-8 leaf and 10-12 leaf
5	Vitazyme (13oz/acre)	6-8lf
6	Siapton (1.5pints/acre)	6-8 leaf
7	Coron (1gal/acre)	6-8 leaf and 10-12 leaf
8	Voyagro (1pint/acre)	6-8lf

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

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
1	16.5	32.5	13.8	275.0	8895.3	89.8
2	16.5	31.3	13.8	276.8	8635.3	90.5
3	16.7	34.4	14.0	280.8	9750.0	90.6
4	16.7	32.0	14.1	282.8	9013.3	90.9
5	16.9	29.5	14.4	286.5	8432.3	90.9
6	16.7	33.0	14.2	282.8	9314.8	90.9
7	16.1	33.5	13.6	270.3	8736.0	90.4
8	16.9	32.4	14.4	287.7	9296.7	91.3
Mean	16.6	32.1	14.0	280.2	8995.6	90.7
CV%	2.4	7.3	3.4	3.4	7.4	1.0
Pr>F	0.1638	0.3412	0.1909	0.2043	0.2653	0.6930
lsd (0.05)	NS	NS	NS	NS	NS	NS

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

SUGARBEET TOLERANCE TO COMPLEX MIXTURES IN 2020

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Summary

1. Ethofumesate preemergence (PRE) followed by postemergence (POST) herbicides alone or in combinations did not increase sugarbeet injury in the field.

2. High surfactant methylated oil concentrate (HSMOC) increased growth reduction injury from Lorsban plus Stinger applied with glyphosate, ethofumesate and Outlook, 7 days after treatment (DAT). HSMOC with herbicide combinations did not increase growth reduction or impact fresh weigh at 14 DAT.

3. Stinger plus Lorsban mixed with glyphosate, ethofumesate and Outlook caused greater growth reduction injury compared with Outlook plus glyphosate and ethofumesate.

4. HSMOC rate should be reduced when Lorsban is mixed with glyphosate, ethofumesate and a chloroacetamide. HSMOC should be eliminated from the mixture when/if Stinger and Lorsban are mixed with glyphosate, ethofumesate and a chloroacetamide herbicide.

Introduction

Sugarbeet herbicides may be tank mixed legally if all herbicides in the mixture are registered for use on sugarbeet and if no prohibitions against tank mixes appear on a label. Combinations of postemergence herbicides can improve the spectrum of weeds controlled and provide greater total weed control, compared with individual treatments. Mixtures also improve time efficiency as compared with making individual applications. However, the risk of sugarbeet injury also increases with combinations, so combinations should be used with caution. Glyphosate is frequently combined with other herbicides including ethofumesate, Stinger, or a chloroacetamide herbicide (Dual, Outlook, or Warrant) in sugarbeet. On occasion, growers may mix as many as five active ingredients into a single mixture.

Observations of malformation and necrosis injury from POST Betamix and Stinger applied in combination with glyphosate, ethofumesate, and S-metolachlor were assessed in a field near Amenia, ND in 2019. We later learned the sugarbeet field had also been treated with ethofumesate PRE at 3 pt/A. Researchers have reported ethofumesate PRE may change the texture of surface waxes thus increasing the sensitivity of sugarbeet to POST herbicides (Abulnaja et al. 1992).

We have coined the term ‘complex mixtures’ to describe combinations of three or more herbicides applied POST to sugarbeet. We anticipate two outcomes for the immediate future. First, ethofumesate PRE will be used on more acres for control of waterhemp and kochia in sugarbeet. Second, complex mixtures will be more commonplace in our pursuit of broad spectrum and effective control of glyphosate-resistant weeds.

Objective

The objective of this research was a) to investigate sugarbeet injury from ethofumesate PRE followed by POST mixtures with glyphosate and b) to investigate the role of HSMOC in relation to sugarbeet injury when applied with complex mixtures.

Materials and Methods

Field. Experiments evaluating sugarbeet injury from ethofumesate PRE followed by POST mixtures with glyphosate were conducted near Christine, ND and Prosper, ND in 2020. 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. Herbicide treatments were applied on May 12 and June 11, and May 30 and June 18 at Christine and Prosper, respectively, with a bicycle wheel sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 43 psi. The treatment list can be found in Table 1. Visible sugarbeet necrosis, malformation, and growth reduction injury was evaluated at both field locations. All evaluations were a visual estimate of injury phenotypes 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 2020.2 software package.

Table 1. Herbicide treatment, rate, and application timing at Christine and Prosper, ND in 2020.

Preemergence (PRE) Treatment	Postemergence (POST) Treatment	Rate (fl oz / A)	Sugarbeet stage (lvs)
-[1]	Glyphosate + Nortron[2]	32 + 12	2-4
-	Glyphosate + Nortron + Stinger	32 + 12 + 6	2-4
-	Glyphosate + Nortron + Stinger + Outlook	32 + 12 + 6 +21	2-4
-	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx	32 + 12 + 6 +21 + 4	2-4
-	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx + Betamix	32 + 12 + 6 +21+ 4 + 32	2-4
Nortron[3]	Glyphosate + Nortron	32 + 12	PRE / 2-4
Nortron	Glyphosate + Nortron + Stinger	32 + 12 + 6	PRE / 2-4
Nortron	Glyphosate + Nortron + Stinger + Outlook	32 + 12 + 6 +21	PRE / 2-4
Nortron	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx	32 + 12 + 6 +21 + 4	PRE / 2-4
Nortron	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx + Betamix	32 + 12 + 6 +21+ 4 + 32	PRE / 2-4

[1] – indicates that no PRE herbicide was applied but that POST applications were applied at the leaf stage shown.
[2]All POST entries included Destiny HC (HSMOC) + N-Pak Liquid AMS at 1.5 pt/A + 2.5% v/v. Glyphosate used was Roundup PowerMax.
[3]Nortron was applied at 3 pt/A PRE.

Greenhouse. Greenhouse experiments were conducted in 2019, 2020, and 2021 to evaluate sugarbeet injury from complex mixtures POST with or without ethofumesate PRE as well as complex mixtures with or without HSMOC. Greenhouse experiments were a randomized complete block design with a factorial treatment arrangement and three or four replications. Treatment factors were herbicide treatment and PRE herbicide treatment or adjuvant depending on the experiment. Herbicides were applied PRE to 2-4 leaf sugarbeet. Plants were grown at 24 to 27C for a 16 h photoperiod under natural light supplemented with artificial lighting. Plants were watered and fertilized as necessary. Herbicide treatments were applied using a spray booth (Generation III, DeVries Manufacturing, Hollandale, MN) equipped with a single 8001 XR nozzle calibrated to deliver 11 gpa spray solution at 40 psi and 3 mph. The herbicide treatment lists are found in Tables 2 and 3.

Table 2. Herbicide treatment, rate, and application timing in the greenhouse in 2019 and 2020.

Preemergence (PRE) Treatment	Postemergence (POST) Treatment	Rate (fl oz / A)	Sugarbeet stage (lvs)
-[1]	Glyphosate + Nortron[2]	32 + 12	2-4
-	Glyphosate + Nortron + Stinger	32 + 12 + 6	2-4
-	Glyphosate + Nortron + Stinger + Dual Magnum	32 + 12 + 6 + 20	2-4
-	Glyphosate + Nortron + Stinger + Dual Magnum + Betamix	32 + 12 + 6 + 20 + 32	2-4
-	Glyphosate + Nortron + Stinger + Dual Magnum + Betamix + Lorsban	32 + 12 + 6 + 20 + 32 + 16	2-4
Ethofumesate 4 SC[3]	Glyphosate + Nortron	32 + 12	PRE / 2-4
Ethofumesate 4 SC	Glyphosate + Nortron + Stinger	32 + 12 + 6	PRE / 2-4
Ethofumesate 4 SC	Glyphosate + Nortron + Stinger + Dual Magnum	32 + 12 + 6 + 20	PRE / 2-4
Ethofumesate 4 SC	Glyphosate + Nortron + Stinger + Dual Magnum + Betamix	32 + 12 + 6 + 20 + 32	PRE / 2-4
Ethofumesate 4 SC	Glyphosate + Nortron + Stinger + Dual Magnum + Betamix + Lorsban	32 + 12 + 6 + 20 + 32 + 16	PRE / 2-4

[1]– indicates that no PRE herbicide was applied but that POST applications were applied at the leaf stage shown.
[2]All POST entries included Destiny HC (HSMOC) + N-Pak AMS at 1.5 pt/A + 2.5% v/v. Glyphosate was Roundup PowerMax.
[3]Ethofumesate 4 SC was applied at 3 pt/A PRE.

Table 3. Herbicide treatment, rate, and application timing in the greenhouse in 2020 and 2021.

Postemergence Treatment[1]	Rate (fl oz / A)	Adjuvant	Sugarbeet stage (lvs)
Glyphosate + ethofumesate	32 + 12	-	2-4 lvs
Glyphosate + ethofumesate + Outlook	32 + 12 + 21	-	2-4 lvs
Glyphosate + ethofumesate + Outlook + Lorsban	32 + 12 + 21 + 16	-	2-4 lvs
Glyphosate + ethofumesate + Outlook + Lorsban + Stinger	32 + 12 + 21 + 16 + 6	-	2-4 lvs
Glyphosate + ethofumesate	32 + 12	HSMOC[2]	2-4 lvs
Glyphosate + ethofumesate + Outlook	32 + 12 + 21	HSMOC	2-4 lvs
Glyphosate + ethofumesate + Outlook + Lorsban	32 + 12 + 21 + 16	HSMOC	2-4 lvs
Glyphosate + ethofumesate + Outlook + Lorsban + Stinger	32 + 12 + 21 + 16 + 6	HSMOC	2-4 lvs

[1]All mixtures contained N-Pak Liquid AMS at 2.5% v/v. Glyphosate used was Roundup PowerMax and ethofumesate was Ethofumesate 4SC.
[2]HSMOC=Destiny HC at 1.5 pt/A.

Visual sugarbeet injury evaluations (0 to 100% with 100% reflecting complete sugarbeet death) were completed 3, 7, and 14 (±3) DAT. Above-ground fresh weight (g pot^{-1}) were collected at the conclusion of the experiment or after the 14 DAT evaluation. Data were analyzed with the ANOVA procedure of ARM, version 2020.4 software package.

Results

Field. The Christine experiment was discontinued due to poor sugarbeet stands. At Prosper, PRE ethofumesate had minimal effect on sugarbeet injury across POST treatments (Factor A) or ethofumesate did not increase sugarbeet injury from postemergence herbicides, even when Betamix was part of the mixture (Factor A × B) (Table 4).

Table 4. Sugarbeet growth reduction in response to preemergence and postemergence herbicide treatments at Prosper, ND in 2020.

Preemergence Herbicide	Postemergence (POST) Herbicide	Rate	Growth Reduction 10 DAT[1]	20 DAT	Mean[2]
		------fl oz/A------	------------%------------		
-	Glyphosate + Nortron[4]	32 + 12	5	0	5
-	Glyphosate + Nortron + Stinger	32 + 12 + 6	0	0	0
-	Glyphosate + Nortron + Stinger + Outlook	32 + 12 + 6 +21	26	9	20
-	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx	32 + 12 + 6 +21 + 4	30	25	26
-	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx + Betamix	32 + 12 + 6 +21+ 4 + 32	58	28	47
Nortron[3]	Glyphosate + Nortron	32 + 12	3	0	4
Nortron	Glyphosate + Nortron + Stinger	32 + 12 + 6	10	9	13
Nortron	Glyphosate + Nortron + Stinger + Outlook	32 + 12 + 6 +21	12	10	16
Nortron	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx	32 + 12 + 6 +21 + 4	31	21	33
Nortron	Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx + Betamix	32 + 12 + 6 +21+ 4 + 32	67	20	41
P-Value, Factor A	PRE ethofumesate		0.2847	0.5560	0.6842
P-Value, Factor B	POST Herbicide treatments		0.0001	0.0001	0.0001
P-Value, Factor A×B	PRE herbicide × POST Herbicide treatment		0.1954	0.5112	0.6258

[1]DAT=Days after POST treatment.
[2]Average of growth reduction 5, 10, and 20 DAT.
[3]Nortron was applied at 3 pt/A.
[4]All POST entries included Destiny HC (HSMOC) + N-Pak Liquid AMS at 1.5 pt/A + 2.5% v/v. Glyphosate used was Roundup PowerMax.

Sugarbeet injury 10 DAT, 20 DAT or the average across evaluations was greater when the number of herbicides mixed with glyphosate and ethofumesate increased, averaged across ethofumesate PRE (Table 5). Growth reduction injury was negligible when Stinger was mixed with glyphosate plus ethofumesate but increased when Mustang Maxx was combined with glyphosate, ethofumesate, Stinger and Outlook. Necrosis and malformation damage varied from plant to plant in plots. Sugarbeet injury was greatest or tended to be greatest when Betamix was combined with glyphosate, ethofumesate, Stinger, Outlook and Mustang Maxx. Sugarbeet necrosis injury from mixtures including Betamix was not consistent but generally was negligible (data not presented). Malformation injury was greater when Outlook, Mustang Maxx or Betamix was mixed with glyphosate, ethofumesate and Stinger (data not presented).

Table 5. Sugarbeet growth reduction in response to postemergence herbicide treatments with or without ethofumesate PRE at Prosper, ND in 2020.

		Growth Reduction		
Postemergence (POST) Herbicide[1]	Rate	10 DAT[2]	20 DAT	Mean[2]
	--------fl oz/A--------	------------------%------------------		
Glyphosate + Nortron	32 + 12	4 c	0 c	5 d
Glyphosate + Nortron + Stinger	32 + 12 + 6	5 c	4 bc	6 d
Glyphosate + Nortron + Stinger + Outlook	32 + 12 + 6 +21	19 b	9 b	18 c
Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx	32 + 12 + 6 +21 + 4	30 b	23 a	29 b
Glyphosate + Nortron + Stinger + Outlook + Mustang Maxx + Betamix	32 + 12 + 6 + 21+ 4 + 32	62 a	24 a	44 a
P-value		0.0001	0.0001	0.0001

[1]All POST entries included Destiny HC (HSMOC) + N-Pak Liquid AMS at 1.5 pt/A + 2.5% v/v. Glyphosate used was Roundup PowerMax.DAT=Days after POST treatment.
[2]Average of growth reduction 5, 10, and 20 DAT.

Greenhouse. Ethofumesate 4SC at 3 pt/A PRE did not affect sugarbeet malformation or growth reduction from POST herbicide treatments and, in general, did not have any effect on sugarbeet necrosis (Table 6).

Table 6. Sugarbeet necrosis, malformation, and growth reduction injury from postemergence herbicide treatments with and without Ethofumesate 4SC PRE at 3 pt/A in the greenhouse in 2020.

	Necrosis[2]		Malformation		Growth Reduction	
Herbicide treatment[1]	No PRE	PRE	No PRE	PRE	No PRE	PRE
	---------------------------------%---------------------------------					
Base[3]	1 c[4]	1 c	3	5	2	3
Base + Stinger	0 c	2 c	17	15	2	4
Base + Stinger + Dual Magnum	7 bc	0 c	12	10	0	4
Base + Stinger + Dual Magnum + Betamix	11b	11 b	30	27	22	11
Base + Stinger + Dual Magnum + Betamix + Lorsban	23 a	13 b	25	27	18	19
P-Value	0.0241		0.9159		0.1594	

[1]All POST entries included Destiny HC (HSMOC) + N-Pak Liquid AMS at 1.5 pt/A + 2.5% v/v.
[2]Necrosis, malformation and growth reduction averaged across evaluations.
[3]Base = Roundup PowerMax at 32 fl oz/A + Ethofumesate 4SC at 12 fl oz/A.
[4]Means within a main effect not sharing any letter are significantly different by the LSD at the 10% level of significance.

Due to the lack of effect from Ethofumesate 4SC PRE, data were combined to the POST treatment level (Table 7). The addition of Betamix and Lorsban increased sugarbeet necrosis, malformation, and growth reduction injury compared with glyphosate plus ethofumesate or glyphosate plus ethofumesate plus Stinger.

Table 7. Sugarbeet necrosis, malformation, and growth reduction injury in response to postemergence herbicide treatments averaged across PRE herbicide in the greenhouse in 2020.

Herbicide treatment[1]	Necrosis[2]	Malformation	Growth Reduction
	------------------------------	%------------------------------	
Base[3]	1 c[4]	4 c	3 b
Base + Stinger	1 c	16 b	3 b
Base + Stinger + Dual Magnum	3 c	11 bc	2 b
Base + Stinger + Dual Magnum + Betamix	11 b	28 a	17 a
Base + Stinger + Dual Magnum + Betamix + Lorsban	18 a	26 a	18 a
P-Value	0.0001	0.0001	0.0001

[1]All POST entries included Destiny HC (HSMOC) + N-Pak Liquid AMS at 1.5 pt/A + 2.5% v/v.
[2]Necrosis, malformation and growth reduction averaged across evaluations.
[3]Base = Roundup PowerMax at 32 fl oz/A + Ethofumesate 4SC at 12 fl oz/A.
[4]Means within a main effect not sharing any letter are significantly different by the LSD at the 10% level of significance.

The second greenhouse experiment considered both the visual assessment of sugarbeet growth reduction injury and sugarbeet fresh weight (g/pot) in response to herbicide mixtures both with and without HSMOC. Sugarbeet injury from glyphosate + ethofumesate + Outlook + Stinger + Lorsban was greatest 7 DAT and was greater or tended to be greater when HSMOC was added with the mixture (Table 8). Injury decreased with time and HSMOC, when added to herbicide mixtures, did not influence growth reduction or fresh weight at 14 DAT.

Visible sugarbeet growth reduction injury at 7 and 14 DAT increased when Outlook or Outlook + Lorsban +/- Stinger was mixed with glyphosate plus ethofumesate (Table 9). Growth reduction injury tended to be less 14 DAT than 7 DAT indicating that plants were starting to recover from their injury. Sugarbeet fresh weight per pot tended to be reduced as the complexity of mixtures increased.

Table 8. The effect of herbicide mixtures both with and without high surfactant methylated oil (HSMOC) on visual sugarbeet growth reduction injury and fresh weight averaged across two greenhouse runs in 2020 to 2021.

Herbicide treatment	Rate	Growth Reduction 7 DAT[1]		Growth Reduction 14 DAT		Fresh Weight	
		No HSMOC	HSMOC	No HSMOC	HSMOC	No HSMOC	HSMOC
	--fl oz/A--	----------------------	%----------------------			-------g/pot-------	
Base[2]		6 ab[3]	1 a	6	12	32.6	30.3
Base + Outlook	21	18 c	15 bc	17	23	30.3	27.8
Base + Outlook and Lorsban	21 + 16	22 c	34 d	19	23	29.4	26.3
Base + Outlook, Lorsban and Stinger	21 + 16 + 6	38 d	49 e	32	39	29.8	28.0
P-Value		0.0257		0.9401		0.9869	

[1]DAT=Days after POST treatment.
[2]Base= Roundup PowerMax at 32 fl oz/A + Ethofumesate 4SC at 12 fl oz/A + N-Pak Liquid AMS at 2.5% v/v.
[3]Means within a main effect not sharing any letter are significantly different by the LSD at the 10% level of significance.

Table 9. The effect of herbicide mixtures averaged across both with and without high surfactant methylated oil (HSMOC) on visual sugarbeet growth reduction injury and fresh weight averaged across two greenhouse runs in 2020 to 2021.

Herbicide treatment	Rate	Growth Reduction 7 DAT[2]	Growth Reduction 14 DAT	Sugarbeet Fresh Weight
	--fl oz/A--	--------------%	--------------	--g/pot--
Base[2]		4 d[3]	9 c	31.4
Base + Outlook	21	16 c	20 b	29.0
Base + Outlook and Lorsban	21 + 16	28 b	21 b	28.9
Base + Outlook, Lorsban and Stinger	21 + 16 + 6	43 a	35 a	28.1
P-Value		0.0001	<0.0001	0.1436

[1]DAT=Days after POST treatment.
[2]Base= Roundup PowerMax at 32 fl oz/A + Ethofumesate 4SC at 12 fl oz/A + N-Pak Liquid AMS at 2.5% v/v.
[3]Means within a main effect not sharing any letter are significantly different by the LSD at the 10% level of significance.

Malformation injury from Stinger was negligible in these greenhouse experiments (data not presented). However, Stinger did cause greater sugarbeet growth reduction injury when added to Outlook + Lorsban compared with Outlook + Lorsban alone. Sugarbeet growth reduction injury was observed as both stature reduction and speckling of the leaves, presumably from the oils in some of the herbicide formulations as well as in the HSMOC adjuvant.

Conclusion

Pesticides (herbicides, fungicides, and insecticides) approved for use in sugarbeet usually are safe to sugarbeet when applied individually. These same pesticides applied in mixtures, however, occasionally injure sugarbeet since each pesticide must be detoxified by the plant. Environmental stressors such as low air and soil temperatures or saturated soil-water content are conditions that often reduce photosynthesis and may reduce energy needed for the developing sugarbeet to metabolize pesticides (Smith and Schweizer 1983), thus increasing the risk of sugarbeet injury. Sugarbeet is better able to manage biotic or abiotic stressors as it develops; sugarbeet with more leaf area have greater metabolic activity, dissipating the effect of herbicides, and other stressors.

These field and greenhouse experiments suggest sugarbeet injury concerns with complex pesticide mixtures. For example, we observed injured phenotypes suggesting Betamix or Betamix plus Lorsban caused sugarbeet injury. However, we do not believe Betamix or Lorsban alone are the culprits since Betamix with glyphosate and ethofumesate caused necrosis and malformation injury 14 DAT similar to glyphosate and ethofumesate (in full disclosure we never evaluated Lorsban plus glyphosate or ethofumesate compared with glyphosate and ethofumesate alone). But rather injury from Betamix and/or Lorsban are exacerbated by 'activators' such as a Stinger combined with glyphosate, ethofumesate and chloroacetamide herbicides in complex mixtures under certain environmental conditions. HSMOC had less effect on sugarbeet injury than the herbicides did and it's unclear how much of the injury from the herbicide can be attributed to the active ingredient versus the oil content of the formulation.

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WATERHEMP CONTROL IN SUGARBEET IN 2020

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Summary

1. Ethofumesate provided partial waterhemp control at 1.5 pt/A, even when activating rainfall was 21 day after treatment (DAT). However, ethofumesate at rates less than 6 pt/A provided less than 85% waterhemp control. Ethofumesate at greater than 6 to 7.5 pt/A provided 36 or 54 days, respectively, of greater than 85% waterhemp control.
2. Preemergence herbicides are effective for controlling early germinating waterhemp. Waterhemp control was similar with ethofumesate at 2 pt/A and Dual Magnum at 0.75 pt/A but was less than waterhemp control from ethofumesate at 4 pt/A.
3. Herbicide, herbicide rate, or timing of herbicide application did not influence waterhemp control from treatments applied layby.
4. Inter-row cultivation or Liberty applied through a hooded sprayer controlled escaped waterhemp.

Introduction

A survey conducted at the 2020 winter Sugarbeet Growers Seminars indicated waterhemp is the primary weed control challenge in sugarbeet fields in Southern Minnesota Beet Sugar Cooperative, Minn-Dak Farmers' Cooperative, and American Crystal Sugar Cooperative. Early-season weed escapes turn into late-season weed control failures which can lead to weed issues at harvest. There are minimal effective POST herbicide options for rescue control of glyphosate-resistant biotypes, especially when waterhemp is greater than 4-inches tall. Three experiments were conducted in 2020 to evaluate herbicide treatments, timing of herbicide application, and methods of herbicide application to create an effective weed management program.

Objective

The objective of these studies was to understand the weed control methods available and how to best to combine them into a weed control program to control waterhemp in sugarbeet.

Materials and Methods

Experiment 1

Experiments were conducted on natural weed populations near Moorhead, MN and Blomkest, MN in 2020 to evaluate waterhemp control and wheat nurse-crop tolerance to ethofumesate preemergence (PRE) at multiple rates. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Spring wheat at 0.75 bu/A was evenly spread throughout the plot area and incorporated with shallow tillage before ethofumesate application. Sugarbeet was seeded in rows spaced 22 inches apart at approximately 62,000 seeds/A or approximately 4.6 inch spacing between seeds along the row in the experiment at Blomkest, MN but sugarbeet was not planted in the experiment at Moorhead, MN.

Herbicide treatments were applied PRE after planting with a bicycle wheel sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center of the 11 by 40 feet long plots. Treatments consisted of one application of ethofumesate at 0, 1.5, 3.0, 4.5, 6.0 and 7.5 pt/A

Wheat injury and waterhemp control were evaluated visually, beginning approximately twenty-three days after ethofumesate application. Additional waterhemp control was evaluated 43, 56, and 62 DAP (days after planting) at Moorhead and 36, 44, 58, and 77 DAP at Blomkest. All evaluations were a visual estimate of control in the treated area compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.2 software package.

Experiment 2

Experiments were conducted on natural weed populations near Hickson, ND and Blomkest, MN in 2020 to consider sugarbeet tolerance and waterhemp control from preemergence and postemergence herbicides. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in rows spaced 22 inches apart at approximately 62,000 seeds/A or approximately 4.6 inch spacing between seeds along the row.

Herbicide treatments were applied on April 27, May 27, and June 12 at Hickson and Blomkest with a bicycle wheel sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2. Treatment list for Hickson and Blomkest can be found in Table 1 and 2, respectively.

Table 1. Herbicide treatment, rate, and application timing at Hickson, ND in 2020.

Preemergence Herbicide	PRE Rate	Lay-by Herbicide	Lay-by Rate	Stage
	(pt/A)		(fl oz/A)	(lvs)
–	–	–[1]	–[1]	4 / 8
–	–	Dual Magnum[2]	18	4
–	–	Dual Magnum	18	8
–	–	Dual Magnum / Dual Magnum	18 / 18	4 / 8
Dual Magnum	0.75	–	–	4 / 8
Dual Magnum	0.75	Dual Magnum	18	4
Dual Magnum	0.75	Dual Magnum	18	8
Dual Magnum	0.75	Dual Magnum / Dual Magnum	18 / 18	4 / 8
Ethofumesate 4SC	2	–	–	4 / 8
Ethofumesate 4SC	2	Dual Magnum	18	4
Ethofumesate 4SC	2	Dual Magnum	18	8
Ethofumesate 4SC	2	Dual Magnum / Dual Magnum	18 / 18	4 / 8
Ethofumesate 4SC	4	–	–	4 / 8
Ethofumesate 4SC	4	Dual Magnum	18	4
Ethofumesate 4SC	4	Dual Magnum	18	8
Ethofumesate 4SC	4	Dual Magnum / Dual Magnum	18 / 18	4 / 8

[1] – indicates that no lay-by herbicide was applied but that applications of Roundup PowerMax at 28 fl oz/A + Prefer 90 NIS at 0.25% v/v + N-Pak Liquid AMS at 2.5% v/v were applied at the leaf stage shown.
[2]All POST treatments of Dual Magnum also included Roundup PowerMax at 28 fl oz/A + HSMOC at 1.5 pt/A + AMS 2.5% v/v.

Table 2. Herbicide treatment, rate, and application timing at Blomkest, MN in 2020.

Preemergence Herbicide	PRE Rate	Lay-by Herbicide	Lay-by Rate	POST Stage
	(pt/A)		(fl oz/A)	(lvs)
–	–	–[1]	–[1]	4 / 8
–	–	Warrant[2]	48	4
–	–	Warrant	48	8
–	–	Outlook / Outlook	12 / 12	4 / 8
–	–	Warrant / Warrant	48 / 48	4 / 8
–	–	Outlook / Warrant	12 / 48	4 / 8
Ethofumesate 4SC	2	–	–	4 / 8
Ethofumesate 4SC	2	Warrant	48	4
Ethofumesate 4SC	2	Warrant	48	8
Ethofumesate 4SC	2	Outlook / Outlook	12 / 12	4 / 8
Ethofumesate 4SC	2	Warrant / Warrant	48 / 48	4 / 8
Ethofumesate 4SC	2	Outlook / Warrant	12 / 48	4 / 8
Ethofumesate 4SC	4	–	–	4 / 8
Ethofumesate 4SC	4	Warrant	48	4
Ethofumesate 4SC	4	Warrant	48	8
Ethofumesate 4SC	4	Outlook / Outlook	12 / 12	4 / 8
Ethofumesate 4SC	4	Warrant / Warrant	48 / 48	4 / 8
Ethofumesate 4SC	4	Outlook / Warrant	12 / 48	4 / 8

[1] – indicates that no lay-by herbicide was applied but that applications of Roundup PowerMax at 28 fl oz/A + Prefer 90 NIS at 0.25 % v/v + N-Pak Liquid AMS at 2.5% v/v were applied at the leaf stage shown.
[2]All POST treatments of Warrant and Outlook also included Roundup PowerMax at 28 fl oz/A + HSMOC at 1.5 pt/A + AMS at 2.5% v/v.

Sugarbeet tolerance and waterhemp control were evaluated. All evaluations were a visual estimate of control in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.2 software package.

Experiment 3
Experiments were conducted on natural weed populations near Moorhead, MN and Blomkest, MN in 2020 investigating waterhemp control and sugarbeet tolerance from a program approach. The program utilized PRE ethofumesate (either broadcast or in a band) followed by POST herbicides (with or without lay-by herbicides or lay-by timed to different sugarbeet growth stage) and followed by inter-row weed control from either Liberty (glufosinate) (applied through a hooded sprayer) or from inter-cultivation. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in rows spaced 22 inches apart at approximately 62,000 seeds/A or approximately 4.6 inch spacing between seeds along the row.

Preemergence ethofumesate was applied at 6 pt/A. Banded treatments of ethofumesate were applied at 6 pt/A broadcast equivalent in an 11-inch band. Herbicide treatments were applied on May 2, June 1, June 11, and June 17 at Moorhead and April 27, May 27, June 9 and June 16 at Blomkest with a CO_2-pressurized bicycle-wheel sprayer in 17 gpa spray solution. Preemergence treatments were made using TeeJet TP4002E flat fan nozzles and EPOST, POST, and LPOST treatments were broadcast using 8002 XR flat fan nozzles. Liberty treatments were banded between rows using a hooded sprayer at 22 gpa spray solution through TP4002E nozzles pressurized with CO_2 at 35 psi. The treatment list can be found in Table 3.

Table 3. Treatment, application method, and herbicide rate at Moorhead and Blomkest, MN in 2020.

Preemergence Herbicide[1]	Application Method	EPOST[2] / POST Herbicide	Rate	Stage	LPOST[4] Treatment	Rate
	(broadcast or band)		(fl oz/A)	(lvs)		(fl oz/A)
Ethofumesate 4SC	broadcast	RUPM[4] / RUPM[4]	28 / 28	4 / 8	RUPM[4]	22
Ethofumesate 4SC	band	RUPM[4] / RUPM[4]	28 / 28	4 / 8	RUPM[4]	22
Ethofumesate 4SC	band	RUPM[5] + Dual Magnum	32 + 16	4	Liberty	32
Ethofumesate 4SC	band	RUPM[3] + Dual Magnum	32 + 16	8	Liberty	32
Ethofumesate 4SC	band	RUPM[3] + Dual Magnum	32 + 16	4	cultivation	–
Ethofumesate 4SC	band	RUPM[3] + Dual Magnum	32 + 16	8	cultivation	–

[1]Preemerge ethofumesate was applied at 6 pt/A broadcast or equivalent (3 pt/A in 11 inch band)
[2]EPOST = early postemergence at 4 lf-stage; POST = postemergence at 8-lf state; LPOST = late postemergence at 12-lf stage
[3]LPOST treatments were applied as follows: RUPM + N-Pak Liquid AMS at 2.5% v/v was broadcast, Liberty + dry AMS at 3 lb/A was applied to inter-row areas with a hooded sprayer, cultivation was directed to inter-row areas.
[4]RUPM = Roundup PowerMax applied with Ethofumesate at 4 fl oz/A + HSMOC at 1.5 pt/A + N-Pak Liquid AMS at 2.5% v/v.
[5]RUPM = Roundup PowerMax applied with Ethofumesate at 12 fl oz/A + HSMOC at 1.5 pt/A + N-Pak Liquid AMS at 2.5% v/v.

Sugarbeet tolerance and waterhemp control were evaluated. All evaluations were a visual estimate of control in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.2 software package.

Results

Experiment 1. Ethofumesate requires rainfall for activation. The experimental area near Moorhead, MN received 0.4- and 0.5-inch rains 48 and 72 hours, respectively, after ethofumesate application on May 2. Rain fell on the experiment near Blomkest, MN 1 and 9 days after ethofumesate application. However, these rain events did not provide sufficient moisture (0.7-inch rainfall or greater) to activate ethofumesate and activating rainfall did not occur until 21 days after application. Ethofumesate at 4.5 pt/A or greater reduced wheat stand by more than 50% at 23 and 43 DAT. Wheat ground cover loss was negligible at Blomkest, even at the 7.5 pt/A rate.

Growers frequently ask if ethofumesate can be used in concert with a nurse crop to reduce effect of blowing soil on sugarbeet. Our research indicates that oat tolerates soil residual herbicides better than wheat or barley and S-metolachlor is safer on nurse crops than ethofumesate. However, our data from 2020 clearly demonstrated nurse crop survival if offered the opportunity to achieve a head-start before activation of soil applied herbicides.

Waterhemp control was dependent on ethofumesate rate and evaluation timing (Figure 1). Waterhemp control of 85% or greater was seen from ethofumesate at 7.5 pt/A, only as far as 54 days after application, indicating ethofumesate at the full rate does not provide season long waterhemp control. Ethofumesate at 6 pt/A provided greater than 90% control but only for 36 days after planting. Eighty percent or greater waterhemp control was accomplished with ethofumesate at 7.5 pt/A, 6 pt/A, and 4.5 pt/A at 79, 56, and 36 DAP, respectively.

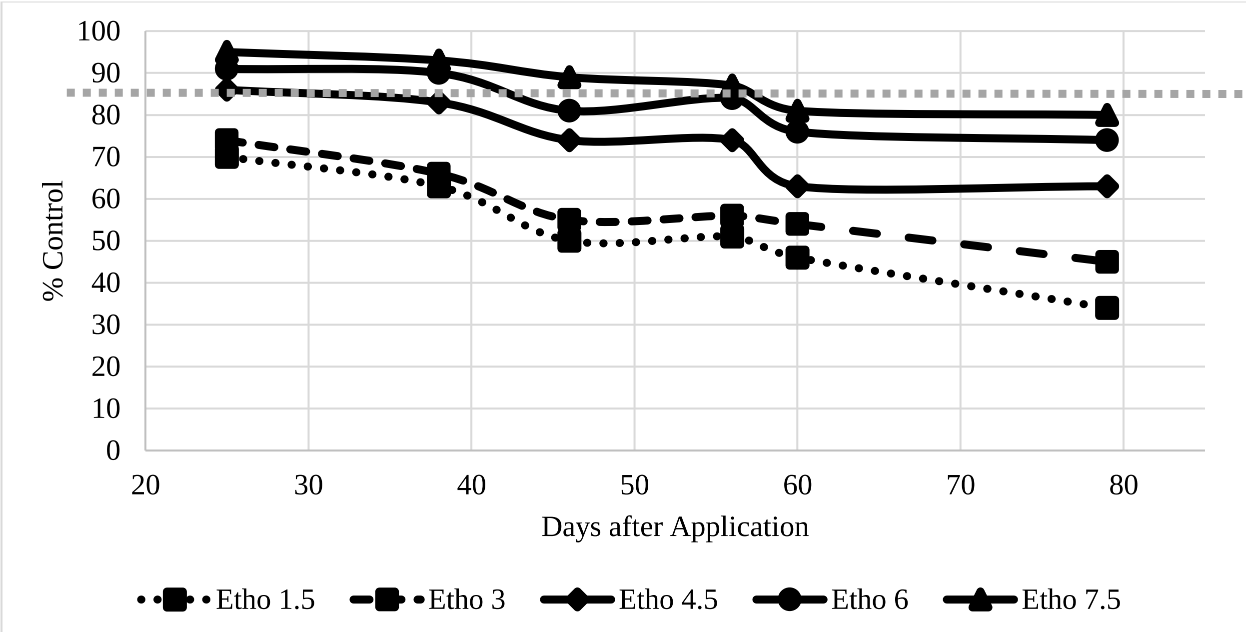

Figure 1. Waterhemp control from increasing ethofumesate rates at Blomkest in 2020.

These spring wheat and waterhemp data suggest we did not properly activate ethofumesate in either experiment in 2020. In addition, waterhemp emergence was much earlier than normal in 2020 than in previous years. An early germinating seed bank means there is less time for herbicide activation before waterhemp emergence.

Experiment 2. This experiment considered a weed management program including preemergence, early postemergence and postemergence herbicides for season-long waterhemp control. Waterhemp control 25 to 28 DAP was dependent on location (Table 4). At Hickson, ND, waterhemp control from ethofumesate at 4 pt/A provided greater waterhemp control than ethofumesate at 2 pt/A or Dual Magnum at 0.75 pt/A. However, at Blomkest, MN, preemergence herbicides did not influence waterhemp control. Preemergence control was influenced by waterhemp emergence date. Waterhemp emergence was documented near Fargo, ND on May 1 and near Mapleton, ND on May 2 (communication with Dr. Joe Ikley, NDSU and Mr. Greg Krause, Minn-Dak Farmers Cooperative) and waterhemp was a uniform and heavy infestation from cotyledon to 2-lf stage on May 28 at Hickson. The waterhemp infestation at Blomkest was sporadic across the experimental area, probably related to dry surface moisture conditions in April and May. Thus, waterhemp PRE control at Blomkest was an estimate of ground cover since the running checks were unreliable due to a light and uneven waterhemp infestation.

Waterhemp control was evaluated 14, 28 and 42 days (+/- 3 days) after POST application at Hickson and 14 days (+/- 3 days) after POST application at Blomkest. Waterhemp control at Hickson will not be presented since there was a tremendous amount of plot to plot variation in POST waterhemp control in the experiment. At Blomkest, waterhemp control from POST herbicide treatments tended to be greatest following ethofumesate at 4 pt/A PRE (Table 5). POST herbicide treatments generally provided similar waterhemp control within PRE treatment.

Table 4. Waterhemp control from the main effect of preemergence herbicide treatment when averaged across postemergence herbicide treatment, 28 DAP at Hickson, ND and 25 DAP at Blomkest, MN in 2020.[1]

Treatment	Rate	Hickson	Blomkest
	--pt/A--	---%---	---%---
No PRE		27 c	81
Dual Magnum	0.75	86 b	–[2]
Ethofumesate	2	85 b	87
Ethofumesate	4	91 a	87
P-value		0.0001	0.1917

[1]Means not sharing any letter are significantly different by t-test at the 5% level of significance.
[2]- treatment was not part of the trial at Blomkest.

Table 5. Waterhemp control 14 days after POST application from PRE, EPOST and POST herbicides at Blomkest in 2020.[1]

Lay-by Treatment[2]	Rate	Timing[3]	No Preemergence Herbicide	Ethofumesate 2 pt/A	Ethofumesate 4 pt/A
	---pt/A---	--lf stage--	------------------------%------------------------		
Warrant	3	4	73 bc	83 ab	90 ab
Warrant	3	8	76 abc	86 ab	89 ab
Outlook/Outlook	0.75 / 0.75	4/8	64 c	79 abc	89 ab
Warrant/Warrant	3 / 3	4/8	76 abc	83 abc	92 a
Outlook/Warrant	0.75 / 3	4/8	72 bc	88 ab	90 ab

[1]Means not sharing any letter are significantly different by t-test at the 20% level of significance.
[2]All POST treatments of Warrant and Outlook also included Roundup PowerMax at 28 fl oz/A + HSMOC at 1.5 pt/A + AMS at 2.5% v/v.
[3]Timing=Sugarbeet leaf stage.

Experiment 3. Grower survey results indicated escaped waterhemp occurred following PRE, EPOST, and POST herbicide treatments. Band applying ethofumesate was a common grower practice before the development of Roundup Ready (RR) sugarbeet. Ethofumesate at 6-pt/A broadcast PRE followed by repeat applications of Roundup PowerMax + ethofumesate controlled waterhemp better than ethofumesate at 6-pt per treated acre (band applied) followed by repeat applications of Roundup PowerMax + ethofumesate (Table 6). Improved control from broadcast applied ethofumesate was most likely due to complete soil coverage as compared with only 11-inches of soil coverage from ethofumesate banded over the sugarbeet row. Waterhemp that emerged between the ethofumesate bands were only partially controlled due to the presence of glyphosate-resistant biotypes. Waterhemp control was improved in treatments where ethofumesate was banded by including Dual Magnum (S-metolachlor) and ethofumesate with Roundup PowerMax applied POST and followed with either inter-row cultivation or an inter-row application of Liberty through a hooded sprayer at the 12 leaf, LPOST, stage.

Table 6. Waterhemp control and recoverable sucrose in response to preemergence and postemergence herbicide treatment, Blomkest and Moorhead, 2020.[1]

Herbicide Treatment	Rate	Blomkest, MN		Moorhead, MN	
		58 DAP[2]	67 DAP	62 DAP	Rec. Suc.[3]
	----fl oz/A----	------------------%------------------			--lb/A--
Ethofumesate / RUPM[4] / RUPM[4] / RUPM[4]	96 / 28 / 28 / 22	99 a	99 a	84 b	6,555
Etho (band) / RUPM[4] / RUPM[4] / RUPM[4]	48 / 28 / 28 / 22	69 b	79 c	76 bc	6,796
Etho (band) / Dual Mag + RUPM[5] + Etho / Liberty (hood)	48 / 16 + 32 + 12 / 32 (hood)	93 a	91 abc	68 c	6,777
Etho (band) / Dual Mag + RUPM[5] + Etho / Inter-row cultivation	48 / 16 + 32 + 12 / (cold hard steel)	100 a	99 ab	99 a	6,952
P value		0.0001	0.0201	0.0001	0.6013

[1]Means not sharing any letter are significantly different by t-test at the 5% level of significance.
[2]DAP=Days after planting.
[3]Rec. Suc. = Recoverable Sucrose.
[4]RUPM = Roundup PowerMax applied with Ethofumesate at 4 fl oz/A + HSMOC at 1.5 pt/A + NPak Liquid AMS at 2.5% v/v.
[5]RUPM = Roundup PowerMax applied with Ethofumesate at 12 fl oz/A + HSMOC at 1.5 pt/A + NPak Liquid AMS at 2.5% v/v.

Summary

Waterhemp control in sugarbeet has been our most important weed management challenge since the beginning of my tenure in 2014. Our research in creating a waterhemp control strategy is based on results from 86 sugarbeet tolerance and waterhemp control experiments since 2014 and has been successfully implemented on over 373,064 acres, where producers identify waterhemp as their most important weed management challenge (according to the 2020 Turning Point survey). The foundation for the program is use of chloroacetamide herbicides (SOA15) early postemergence (EPOST) and postemergence (POST) and in combination with glyphosate and ethofumesate in sugarbeet.

We observed integrating a PRE herbicide into the management plan improved waterhemp control, especially when sugarbeet emergence or timely rainfall to activate chloroacetamide herbicides is delayed (Figure 2). Growers planting after April 20 were encouraged to use a PRE since waterhemp emergence may occur before chloroacetamide herbicide activation. However, 2020 research and commercial experience indicates a PRE should be used regardless of plant date.

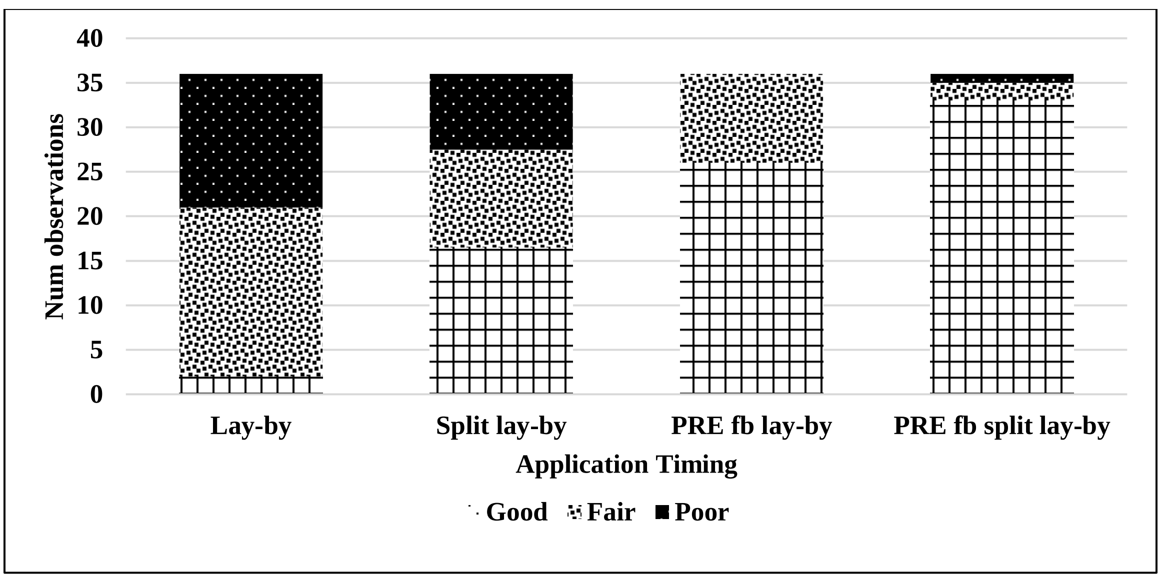

Figure 2. Number of good, fair, and poor estimates of waterhemp control across herbicides and application timing, summed across evaluations, locations, and years.

Surveyed growers attending the 2020 SMBSC seminar in Willmar indicated waterhemp control following PRE and layby application in 2019 did not meet their expectations (31% and 24% of respondents, respectively). POST control of escapes is difficult due to widespread ALS inhibitor (SOA 2) resistance biotypes and depleting Betamix inventories. In 2020, we observed escaped waterhemp can be controlled using inter-row cultivation or by the use of inter-row application of Liberty through a hooded sprayer. BASF Corp is drafting a 24c local needs label for Minnesota and North Dakota for 2021 to allow for this type of application.

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HOODED SPRAYER FOR APPLICATION OF NONSELECTIVE HERBICIDES IN SUGARBEET

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Summary

1. Liberty and Gramoxone are not approved for POST directed application in sugarbeet.

2. Gramoxone at 21 fl oz/A plus non-ionic surfactant (NIS) and Liberty at 32 fl oz/A plus ammonium sulfate (AMS) improved 4- and 6-inch waterhemp control as compared with repeat glyphosate applications at 28 fl oz/A / 28 fl oz/A plus NIS and AMS.

3. PowerMax was more effective than Liberty or Gramoxone for common lambsquarters control.

4. Growth reduction injury was negligible from Gramoxone or Liberty applied at the 6-lf sugarbeet stage or greater and Gramoxone or Liberty did not reduce root yield, sucrose content or recoverable sucrose as compared to repeat glyphosate application.

Introduction

Sugarbeet producers recognized waterhemp as their most troublesome weed control challenge on 373,064 acres or 59% of the production acreage in Minnesota and eastern North Dakota in 2020 (survey conducted at 2020 Sugarbeet Growers Seminars, Turning Technologies, Youngstown, OH). Waterhemp control is maximized by using soil residual herbicides applied preemergence, early postemergence, and postemergence in sugarbeet. Optimal control is dependent on timely rainfall following application to move herbicides into the weed seed zone, or from soil surface to 2-cm into soil. Postemergence (POST) applications of Betamix and UpBeet and inter-row cultivation have been used to control escaping weeds. However, remnant inventories of Betamix have been exhausted, UpBeet-resistant waterhemp populations are increasingly common in the production area, and (re)adoption of inter-row cultivation by sugarbeet growers has been slow.

Selective and nonselective herbicides applied through hooded sprayers are used in cotton production to control weeds between rows. The hood protects cotton plants from herbicides that may cause growth reduction injury. The practicality and value of a hooded sprayer is being evaluated in sugarbeet as herbicide-resistance continues to increase in species such as waterhemp and Palmer amaranth. Experiments conducted in 2020 evaluated sugarbeet tolerance and waterhemp and common lambsquarters control from Roundup PowerMax (glyphosate), Liberty (glufosinate) and Gramoxone (paraquat) applied through a hooded sprayer at multiple locations in North Dakota and Minnesota.

Objectives

Liberty and Gramoxone are not labeled in sugarbeet and will require action by Minnesota and North Dakota Department of Agriculture before use, even between rows through a hooded sprayer. Thus, sugarbeet tolerance and weed control must be measured before support can be solicited from industry and a petition submitted to the Department of Agriculture. The objectives of these research were to determine sugarbeet tolerance and weed control when Liberty or Gramoxone were applied at different rates and timings through a hooded sprayer.

Materials and Methods

Sugarbeet Tolerance. Experiments were conducted near Crookston, MN, Lake Lillian, MN, Hickson, ND, and Prosper, ND in 2020. The Hickson, ND location was not included in the analysis due to erratic sugarbeet stands. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was planted between April 27 and May 27, 2020.

Herbicide treatments were applied between each row within a 30-foot long by six row plot when sugarbeet was at the 2-, 6-, and 10-lf stage using a hooded sprayer traveling 3 mph delivering 22 gpa spray solution through 8002 EVS Teejet nozzles pressurized with CO_2 at 35 psi. The treatment list can be found in Table 1.

Table 1. Herbicide treatments, rates, and application timing in trials near Prosper, ND and Lake Lillian and Crookston, MN in 2020.

Herbicide treatment	Rate (fl oz/A)	Sugarbeet stage (lvs)
RU PowerMax / RU PowerMax[1]	28 /28	4 / 6-8
Liberty[2]	86	2-4
Liberty	86	6-8
Liberty	86	10-12
Gramoxone SL 3.0[3]	32	2-4
Gramoxone SL 3.0	32	6-8
Gramoxone SL 3.0	32	10-12

[1]Treatments with Roundup PowerMax applied with Prefer 90 NIS at 0.25% v/v + N-Pak AMS Liquid at 2.5% v/v.
[2]Treatments with Liberty applied with dry AMS at 3 lb/A.
[3]Treatments with Gramoxone SL 3.0 applied with Prefer 90 NIS at 1 qt/A.

Sugarbeet injury was evaluated as a visual estimate of percent growth reduction (0 to 100% scale, 0 is no visible injury and 100 is complete loss of plant / stand) in the middle four rows of the six-row plot compared to the glyphosate check. Leaf damage ratings were also evaluated by counting the number of sugarbeet plants within treated rows with visual damage. Damage factors included herbicide drift, operator or equipment error, environment, etc. Sugarbeet was harvested from the center two rows within a plot in the fall and assessed for yield and quality. Data were analyzed using either SAS Data Management software PROC MIXED procedure to test for significant differences at p=0.05 or the ANOVA procedure of ARM, version 2020.2 software package depending on variable. Experimental design was randomized complete block with six replications.

Hooded Sprayer Efficacy. Experiments were conducted on native populations of common lambsquarters and waterhemp in sugarbeet fields near Moorhead and Lake Lillian, MN and Galchutt and Hickson, ND in 2020. The Galchutt location was dropped due to insufficient waterhemp populations; the Hickson site was dropped due to sprayer mechanical challenges. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was planted April 28th and May 19th at Lake Lillian and Moorhead, respectively.

Herbicide treatments were applied between each row within a 30-foot long by six row plot when waterhemp was 3- or 6-inches tall using a hooded sprayer delivering 22 gpa spray solution through 8002 EVS Teejet nozzles pressurized with CO_2 at 35 psi. The treatment list can be found in Table 2.

Table 2. Herbicide treatments, rates, and application timing in trials near Moorhead and Lake Lillian, MN in 2020.

Herbicide treatment	**Rate (fl oz /A)**	**Waterhemp (inch)**
RU PowerMax / RU PowerMax[1]	28 / 28	2 to 4 fb 10 d
Liberty[2]	32	3-4
Liberty	32	6-8
Liberty	43	3-4
Liberty	43	6-8
Gramoxone SL 3.0[3]	21	3-4
Gramoxone SL 3.0	21	6-8
Gramoxone SL 3.0	32	3-4
Gramoxone SL 3.0	32	6-8

[1]Treatments with Roundup PowerMax applied with Prefer 90 NIS at 0.25% v/v + N-Pak Liquid AMS at 2.5% v/v.
[2]Treatments with Liberty applied with dry AMS at 3 lb/A.
[3]Treatments with Gramoxone SL 3.0 applied with Prefer 90 NIS at 1 qt/A.

Weed control was evaluated as a visual estimate of percent fresh weight reduction (0 is no injury and 100 is complete control) in the four treated rows compared to the glyphosate check at 7, 14, and 21 days (+/- 3 days) after application. Experimental design was randomized complete block with four replications. Data were analyzed with the ANOVA procedure of ARM, version 2020.4 software package.

Tolerance Results

Tolerance Probe. Experiments conducted by BASF Corp at two locations in 2020 evaluated RR sugarbeet tolerance to glufosinate in an over-the-top application using a rate titration of 1x, 1/10x, 1/100x, and 1/1000x the recommended rate applied to 4- and 8-lf sugarbeet (Table 3). The research simulated sugarbeet injury from spray solution escaping from hoods at two growth stages. Sugarbeet were sensitive to Liberty, especially at 43 fl oz/A at the 4-lf stage. However, injury was less at the 10-lf stage or with the 1/10, 1/100 or 1/1000x Liberty rate. No injury to either the 4- or 10-lf stage sugarbeet was observed at the 1/100x or 1/1000x rate. The experiment demonstrated sugarbeet sensitivity to glufosinate when sprayed over the top of sugarbeet; however, sugarbeet may not be as susceptible to injury when applications are made through a hooded sprayer.

Table 3. RR sugarbeet tolerance to Liberty herbicide following broadcast application.[1]

			Injury 4 DAT[2]	
Treatment	Rate	Rate	4-lf Sugarbeet	10-lf Sugarbeet
	fl oz/A		----------------%----------------	
Liberty[3]	43	1x	100	70
Liberty	4.3	1/10x	30	15
Liberty	0.43	1/100x	0	0
Liberty	0.043	1/1000x	0	0

[1]Bird Island, MN plot ratings by Dr. Duane Rathmann, BASF Corp.
[2]DAT=Days after treatment.
[3]All Liberty treatments applied with dry AMS at 3 lb/A.

Sugarbeet growth reduction injury from herbicides applied through a hooded sprayer was negligible across application timings (Table 4). Injury was divergence from a uniform stand and tended to represent damage to specific sugarbeet plants and not uniform damage across the plot. Numerically, growth reduction injury was greatest following either Liberty or Gramoxone application at the 2 to 4 leaf sugarbeet. We did not observe any difference in injury between Liberty and Gramoxone. Injury became less as sugarbeet grew and was not observed or was negligible at 14 or 21 DAT (data not presented). Leaf damage counts represent single locations since the cause of damage was experiment specific (Table 4). Leaf damage injury from Gramoxone was generally greater than from Liberty. Leaf damage at the 2- to 4-lf stage at Lake Lillian may have been extenuated by breeze conditions at application. Damage ratings at the 10- to 12-leaf stage is likely from wheel traffic, especially since it was not supported by the growth reduction observations. Damage was less as sugarbeet developed and was negligible 14 or 21 DAT (data not presented). Root yield, % sucrose, and recoverable sucrose from Liberty or Gramoxone through the hooded sprayer was the same as yield parameters treated with repeat glyphosate application (Table 5). However, Liberty and Gramoxone at the 2- to 4-leaf stage applications tended to give root yield less than the glyphosate check.

Table 4. Growth reduction, averaged across three environments and number of damaged plants in plots, by environment, in response to POST herbicides through the hooded sprayer in 2020.[1]

		Growth Reduction	Damaged Plants		
		Across Locations	Crookston, MN	Prosper, ND	Lake Lillian, MN
Herbicide treatment	**Sugarbeet stage**	7 DAT[2]	7 DAT	7 DAT	7 DAT
	--lvs--	--%--	-------------# plants/plot-------------------		
RU PowerMax / RU PowerMax	4 / 6-8	1	6 a	2 a	4 a
Liberty	2-4	15	11 ab	2 a	81 b
Liberty	6-8	7	5 a	2 a	19 ab
Liberty	10-12	9	80 e	45 c	13 a
Gramoxone SL 3.0	2-4	16	23 bc	2 a	134 c
Gramoxone SL 3.0	6-8	10	46 d	9 a	31 ab
Gramoxone SL 3.0	10-12	7	27 c	30 b	30 ab
		---------------------------------*P*-value----------------------------			
		0.0925	<0.0001	<0.0001	<0.0001

[1]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.
[2]DAT=Days after treatment.

Table 5. Root yield, sucrose content, and recoverable sucrose in response to POST herbicides through the hooded sprayer, across three environments, in 2020.[1]

Herbicide treatment	**Sugarbeet stage**	**Root Yield[2]**	**Sucrose Content**	**Rec. Suc[3]**
	--lvs--	--Tons/A--	--%--	--lb/A--
RU PowerMax / RU PowerMax	4 / 6-8	30.1	16.2	8,628
Liberty	2-4	27.9	16.4	8,055
Liberty	6-8	29.3	16.2	8,789
Liberty	10-12	29.2	16.0	8,468
Gramoxone SL 3.0	2-4	27.9	16.4	8,392
Gramoxone SL 3.0	6-8	29.2	16.1	8,680
Gramoxone SL 3.0	10-12	28.6	16.0	8,362
		-----------------------------*P*-value--------------------		
		0.3146	0.8799	0.6049

[1]Means within a main effect not sharing any letter are significantly different by the LSD at the 5% level of significance.
[2]Root yield reported in ton per acre.
[3]Recoverable sucrose reported in pound per acre.

Efficacy Results

The first observation of symptomology was herbicide specific in efficacy experiments. A necrosis phenotype was observed from Gramoxone 1 DAT on waterhemp and common lambsquarters. Symptomology from Liberty was observed first on waterhemp and second on lambsquarters 5- to 7-DAT. Symptomology from glyphosate was slowest to be observed, especially on waterhemp. Gramoxone applied through the hooded sprayer improved waterhemp control compared to repeat glyphosate applications (Table 6). Waterhemp control from Gramoxone was not influenced by weed size or application rate. Waterhemp control from Liberty was dependent on rate and weed size. Liberty at 32 fl oz/A provided or tended to provide control of 3- to 4-inch waterhemp greater than 6- to 8-inch waterhemp. Waterhemp size did not influence control when Liberty was applied at 43 fl oz/A. However, Liberty applied at 43 fl oz/A tended to provide greater control of 3- to 4-inch waterhemp compared to 6-to 8-inch waterhemp.

Table 6. Waterhemp and common lambsquarters control in response to POST herbicides applied through the hooded sprayer, 2020.[1]

Herbicide treatment	Rate	Weed Height	Waterhemp	Common Lambsquarters Lake Lillian	Common Lambsquarters Moorhead
	-fl oz/A-	----inch----	---%	---	---
RU PowerMax / RU PowerMax	28 / 28	2 to 4 fb 10 d	55 c	94 a	99 a
Liberty	32	3-4	81 ab	65 c	77 de
Liberty	32	6-8	56 c	29 e	81 cd
Liberty	43	3-4	86 ab	79 b	85 bcd
Liberty	43	6-8	70 bc	41 d	86 bcd
Gramoxone SL 3.0	21	3-4	90 a	89 a	77 de
Gramoxone SL 3.0	21	6-8	90 a	65 c	73 e
Gramoxone SL 3.0	32	3-4	96 a	94 a	93 ab
Gramoxone SL 3.0	32	6-8	96 a	85 ab	89 bc
			---*P*-value---		
			0.0020	<0.0001	<0.0001

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

Common lambsquarters ranged from 6- to 12-inches at Lake Lillian due to high wind conditions in June which delayed application timings. Lambsquarters was sprayed according to protocol at Moorhead, MN. Thus, lambsquarters control was not combined and are reported separately for each experiment. Glyphosate was equally effective at controlling small and large common lambsquarters in this experiment. At Lake Lillian, control from Liberty was dependent on rate and lambsquarters size at application. However, common lambsquarters control from Liberty was the same across rates and height at Moorhead where applications were successfully timed to protocol. Lambsquarters control from Liberty was less than control from glyphosate and tended to be less than control from Gramoxone at both locations. Common lambsquarters control differences from Liberty and Gramoxone were much less at Moorhead than at Lake Lillian where Gramoxone gave greater lambsquarters control at a given weed size compared with control from Liberty. At Moorhead, common lambsquarters height did not affect control from Gramoxone at 21 fl oz/A. However, at Lake Lillian, applying Gramoxone to smaller lambsquarters resulted in greater control at both 21 and 32 fl oz/A.

Conclusions

Liberty and Gramoxone are effective herbicides for controlling waterhemp and can be safely applied inter-row through a hooded sprayer when sugarbeet are at the 6-8 leaf stage or greater. Liberty might be slightly safer than Gramoxone. Weed control from Liberty generally decreases as weed height increases and numerically was better on waterhemp than common lambsquarters. Waterhemp control from Gramoxone was not influenced by rate or height but control of taller lambsquarters was less at Lake Lillian as compared to Moorhead. Waterhemp should be the primary weed control focus when using a hooded sprayer since glyphosate remains highly effective for common lambsquarters control. Liberty at 32 fl oz/A applied to small weeds or Gramoxone at 21 fl oz/A applied to small or large weeds provided improved waterhemp control than glyphosate.

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TURNING POINT SURVEY OF WEED CONTROL AND PRODUCTION PRACTICES IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2019

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The fifth annual weed control and production practices live polling questionnaire was conducted using Turning Point Technology at the 2020 winter Sugarbeet Grower Seminars. Responses are based on production practices from the 2019 growing season. The survey focuses on responses from growers in attendance at the Fargo, Grafton, Grand Forks, Wahpeton, ND, and Willmar, MN, Growers Seminars. Respondents from each seminar indicated the county in which the majority of their sugarbeet were produced (Tables 1, 2, 3, 4, 5). Survey results represents approximately 160,150 acres reported by 245 respondents (Table 6) compared to 174,032 acres represented in 2018. The average sugarbeet acreage per respondent grown in 2019 was calculated from Table 6 at 662 acres compared to 697 acres in 2018.

Survey participants were asked a series of questions regarding their production practices used in sugarbeet in 2019. Fifty-five percent of respondents indicated wheat was the crop preceding sugarbeet (Table 7), 27% indicated corn, and 9% indicated soybean. Preceding crop varied by location with 92% of Grand Forks growers indicating wheat preceded sugarbeet and 72% of Willmar growers indicated corn as their preceding crop. Seventy percent of growers who participated in the winter meetings used a nurse or cover crop in 2019 (Table 8) which decreased from 77% in 2018. Cover crop species also varied widely by location with barley being used by 43% of growers at the Grand Forks meeting and oat or wheat being used by 40% of growers at the Willmar meeting.

Growers indicated Cercospora Leaf Spot (CLS) was their most serious production problem in sugarbeet in 2019 (Table 9) with 27% of all respondents naming CLS. Rhizoctonia was named the second most serious problem by 26% of participants. In 2018, CLS was named the most serious problem by 42% of all respondents. Weeds or emergence/stand were named as most serious by 16% of respondents.

Waterhemp was named as the most serious weed problem in sugarbeet in 2019 by 56% of respondents (Table 10) compared to 54% in 2018. Nine percent of respondents indicated common lambsquarters, 7% kochia, and 18% said common ragweed were their most serious weed problem in 2019. The increased presence of glyphosate-resistant waterhemp and common ragweed are likely the reason for these weeds being named as the worst weeds. Troublesome weeds varied by location with greater than 96%, 80%, and 94% of Willmar, Wahpeton, and Fargo respondents, respectively, indicating waterhemp was most problematic weed. Common ragweed was the worst weed for respondents of the Grand Forks meeting with 56% of responses.

Respondents to the survey indicated making 0 to 4 glyphosate applications in their 2019 sugarbeet crop (Table 11) with a calculated average of 2.05 applications per acre. The calculated average in 2018 was 2.16 applications per acre.

Glyphosate was most commonly applied with a broadleaf herbicide postemergence in 2019 with 34% of responses indicating this herbicide combination was used (Table 12). Glyphosate applied with a chloroacetamide herbicide postemergence (lay-by) was the second most common herbicide used in sugarbeet in 2019 with 31% of responses. Glyphosate alone and glyphosate plus a grass herbicide were the third and fourth most common at 22% and 10% of the responses.

Satisfaction to weed control from glyphosate applied alone is shown in Table 13 and ranged from 23% of responses indicating excellent control to 2% of responses indicating poor weed control. The majority of responses, 38%, indicated glyphosate was still providing good weed control in sugarbeet in 2019.

Preplant incorporated (PPI) or preemergence (PRE) herbicides were applied by 45% of survey respondents in 2019 (Table 14). The most commonly used soil herbicide was S-metolachlor with 21% of all responses followed by ethofumesate with 14% of responses (Table 14). Of the growers who indicated using a soil-applied herbicide, 72% indicated excellent to good weed control from that herbicide (calculated from Table 15).

The application of soil-residual herbicides applied 'lay-by' to the 2019 sugarbeet crop was indicated by 58% of respondents (Table 16). Outlook was the most commonly applied lay-by herbicide with 28% of responses. The majority of growers responding at the Willmar meeting indicated using Outlook (65% of responses), while S-metolachlor was more commonly applied by growers of the Wahpeton (60% of responses) and Fargo (58% of responses) meetings. Ninety-six percent, 100%, and 74% of Willmar, Wahpeton, and Fargo respondents, respectfully, applied glyphosate with Outlook, S-metolachlor, or Warrant but only 17% and 14% of Grand Forks and Grafton respondents, respectfully, used this combination (Table 16). Use of chloroacetamide herbicides with glyphosate seems to coincide greatest to areas where glyphosate-resistant waterhemp is common.

Satisfaction of weed control from lay-by applications ranged from excellent to unsure (Table 17). Of respondents indicating they applied a lay-by herbicide, 75% indicated excellent or good weed control (calculated from Table 17).

Sixty percent of survey respondents indicated using some form of mechanical weed control or hand labor in 2019 (Table 18). Of the responses given, 38% indicated at least some hand-weeding, 16% used row-cultivation, and 2% indicated using a rotary hoe for weed control in sugarbeet. Sixteen percent reported row-crop cultivation on less than ten percent of their acres (Table 19). Of respondents indicating they used row-cultivation, 49% indicated excellent or good weed control (Table 20).

Hand-weeding the 2019 sugarbeet crop was reported by 50% of respondents (Table 21). Most respondents who hand-weeded indicated less than 10% of their acres were hand-weeded. Fewer than half of the respondents indicated hand-weeding at the Grafton, Wahpeton, and Grand Forks meetings, while greater than half the participants at the Fargo and Willmar meeting reported some hand weeding.

Table 1. 2020 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2019.

County	Number of Responses	Percent of Responses
Becker	1	3
Cass	4	11
Clay	15	41
Norman[1]	10	28
Richland	1	3
Traill	4	11
Wilkin[2]	1	3
Total	36	100

[1]Includes Mahnomen County
[2]Includes Otter Tail County

Table 2. 2020 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2019.

County	Number of Responses	Percent of Responses
Kittson	10	20
Marshall	2	4
Pembina	14	27
Polk	4	8
Walsh	21	41
Total	51	100

Table 3. 2020 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2019.

County	Number of Responses	Percent of Responses
Grand Forks	10	15
Marshall	11	16
Polk	36	54
Traill	4	6
Walsh	4	6
Other	2	3
Total	67	100

Table 4. 2020 Wahpeton Grower Seminar - Number of survey respondents by county growing sugarbeet in 2019.

County	Number of Responses	Percent of Responses
Grant	2	18
Richland	1	9
Wilkin	8	73
Total	11	100

Table 5. 2020 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2019.

County	Number of Responses	Percent of Responses
Chippewa	31	34
Kandiyohi	10	11
Redwood	3	3
Renville	29	32
Stevens	4	4
Swift	9	10
Other	5	6
Total	91	100

Table 6. Total sugarbeet acreage operated by respondents in 2019.

		Acres of sugarbeet									
Location	Responses	<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		-------------------------------------% of responses-----------------------------									
Fargo	32	17	9	9	6	25	9	6	3	3	13
Grafton	49	10	6	9	12	16	18	6	4	0	9
Grand Forks	66	9	6	6	5	26	15	6	17	9	1
Wahpeton	8	0	13	13	24	13	13	0	0	24	0
Willmar	90	8	10	14	12	16	20	3	12	4	1
Total	245	9	8	10	10	20	17	5	12	5	4

Table 7. Crop grown in 2018 that preceded sugarbeet in 2019.

		Previous Crop						
Location	Responses	Field Corn	Dry Bean	Potato	Soybean	Wheat	Sweet Corn	Other
		-------------------------------% of responses---------------------------------------						
Fargo	32	3	0	0	16	78	3	0
Grafton	55	0	4	7	2	82	0	5
Grand Forks	66	0	2	2	4	92	0	0
Wahpeton	10	20	0	0	10	70	0	0
Willmar	90	72	1	0	15	1	10	1
Total	253	27	2	2	9	55	4	1

Table 8. Nurse or cover crop used in sugarbeet in 2019.

Location	Responses	Barley	Oat	Rye	Wheat	Other[1]	None
		----------------------------------% of responses------------------------------					
Fargo	36	39	3	0	19	0	39
Grafton	52	33	8	0	17	0	42
Grand Forks	72	43	1	1	18	0	37
Wahpeton	10	50	0	0	50	0	0
Willmar	91	0	40	2	40	0	18
Total	261	26	16	1	27	0	30

[1]Includes Mustard and 'Other'

Table 9. Most serious production problem in sugarbeet in 2019.

Location	Responses	Aph[1]	CLS[2]	Stand[3]	Fusarium	Herbicide Injury	Rhizoc-tonia	Rhizo-mania	Insects	Weeds
		--------------------------------------% of responses--								
Fargo	39	5	28	5	8	0	21	2	0	31
Grafton	56	14	11	21	0	4	29	7	9	5
Grand Forks	62	3	18	35	0	2	21	0	10	11
Wahpeton	9	0	78	0	0	0	22	0	0	0
Willmar	96	3	37	5	2	1	29	1	0	22
Total	262	6	27	16	2	1	26	2	4	16

[1]Aphanomyces
[2]Cercospora Leaf Spot
[3]Emergence/Stand

Table 10. Most serious weed problem in sugarbeet in 2019.

Location	Responses	colq[1]	cora	kochia	gira	rrpw	RR Canola	wahe
		-----------------------------------% of responses---------------------------						
Fargo	35	3	0	3	0	0	0	94
Grafton	54	24	15	28	2	15	7	9
Grand Forks	66	12	56	5	3	6	0	18
Wahpeton	10	0	0	0	0	10	10	80
Willmar	89	1	0	0	1	0	2	96
Total	254	9	18	7	2	5	3	56

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

Table 11. Average number of glyphosate applications per acre in sugarbeet during 2019 season.

Location	Responses	0	1	2	3	4	5
		-------------------------% of responses----------------------------					
Fargo	38	3	13	63	16	5	0
Grafton	50	0	12	66	22	0	0
Grand Forks	69	0	16	70	14	0	0
Wahpeton	9	0	0	44	56	0	0
Willmar	89	0	24	57	16	3	0
Total	255	<1	17	63	18	2	0

Table 12. Herbicides used in a weed control systems approach in sugarbeet in 2019.

		Glyphosate Application Tank-Mixes					
Location	Responses	Gly Alone	Gly+Lay-by	Gly+Broadleaf	Gly+Grass	Other	None Used
		-------------------------------------% of responses-----------------------------------					
Fargo	40	10	38	35	7	3	7
Grafton	54	70	7	19	2	0	2
Grand Forks	72	22	7	67	0	4	0
Wahpeton	13	0	61	23	8	8	0
Willmar	153	9	47	25	18	1	0
Total	332	22	31	34	10	2	1

Table 13. Satisfaction in weed control from glyphosate applied in sugarbeet in 2019.

		Satisfaction of Weed Control from Glyphosate					
Location	Responses	Excellent	Good	Fair	Poor	Unsure	Not Used Alone
		---------------------------------% of responses----------------------------					
Fargo	37	5	22	38	8	3	24
Grafton	50	38	44	16	0	0	2
Grand Forks	68	23	46	9	0	0	22
Wahpeton	9	0	11	33	0	0	56
Total	164	23	38	19	2	<1	18

Table 14. Preplant incorporated or preemergence herbicides used in sugarbeet in 2019.

Location	Responses	PPI or PRE Herbicides Applied					
		S-metolachlor	ethofumesate	Ro-Neet SB	S-metolachor +ethofumesate	Other	None
		--------------------------------------% of responses----------------------------------					
Fargo	38	39	13	3	3	3	39
Grafton	55	2	5	2	0	2	89
Grand Forks	67	9	0	0	0	9	82
Wahpeton	11	18	27	0	9	0	46
Willmar	92	33	28	0	13	2	24
Total	263	21	14	<1	5	4	56

Table 15. Satisfaction in weed control from preplant incorporated and preemergence herbicides in 2019.

Location	Responses	PPI or PRE Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		------------------------------% of responses--------------------------					
Fargo	35	6	34	14	0	9	37
Grafton	51	2	4	2	0	0	92
Grand Forks	72	10	10	0	0	0	80
Wahpeton	10	40	20	10	0	0	30
Willmar	92	12	42	22	3	1	20
Total	260	10	24	10	1	2	53

Table 16. Soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2019.

Location	Responses	Lay-by Herbicides Applied				
		S-metolachlor	Outlook	Warrant	Other	None
		----------------------------------% of responses---------------------------------				
Fargo	38	58	10	3	3	26
Grafton	44	10	0	2	2	86
Grand Forks	64	16	1	0	0	83
Wahpeton	10	60	30	10	0	0
Willmar	93	4	65	27	0	4
Total	249	18	28	11	1	42

Table 17. Satisfaction of weed control from soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2019.

Location	Responses	Lay-by Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		--------------------------------% of responses--------------------------					
Fargo	35	6	57	9	3	11	14
Grafton	48	2	2	8	2	0	86
Grand Forks	64	8	8	2	0	2	80
Wahpeton	10	40	60	0	0	0	0
Willmar	90	16	57	21	2	0	4
Total	247	11	34	11	1	2	41

Table 18. Mechanical weed control methods used in sugarbeet in 2019.

Location	Responses	Rotary Hoe	Row-Cultivation	Hand-Weeded	Other	None
		-------------------------------------% of responses-----------------------------------				
Fargo	43	0	19	46	5	30
Grafton	51	2	10	31	2	55
Grand Forks	70	3	4	32	0	61
Wahpeton	10	0	10	20	0	70
Willmar	113	3	26	44	5	22
Total	287	2	16	38	4	40

Table 19. Percent of sugarbeet acres row-crop cultivated in 2019.

		% Acres Row-Cultivated				
Location	Responses	0	< 10	10-50	51-100	>100
		----------------------------------% of responses------------------------------				
Fargo	36	69	28	3	0	0
Grafton	51	78	16	4	0	2
Grand Forks	67	81	19	0	0	0
Wahpeton	10	70	20	10	0	0
Willmar	86	63	9	8	8	12
Total	250	72	16	5	3	4

Table 20. Satisfaction of weed control from row-crop cultivation in sugarbeet in 2019.

		Cultivation Weed Control Satisfaction					
Location	Responses	Excellent	Good	Fair	Poor	Unsure	None Used
		--------------------------------% of responses---------------------------					
Fargo	36	0	20	11	8	0	61
Grafton	50	0	12	4	0	6	78
Grand Forks	68	1	12	0	0	3	84
Wahpeton	10	20	0	10	0	0	70
Willmar	86	3	10	19	3	2	63
Total	250	2	12	9	1	3	72

Table 21. Percent of sugarbeet acres hand-weeded in 2019.

		% Acres Hand-Weeded				
Location	Responses	0	< 10	10-50	51-100	>100
		-----------------------------------% of responses------------------------------				
Fargo	35	26	51	17	3	3
Grafton	52	65	29	4	2	0
Grand Forks	71	68	31	1	0	0
Wahpeton	10	80	20	0	0	0
Willmar	88	32	24	27	9	8
Total	256	50	30	13	4	3

Appendix. Trials conducted in the SMBSC growing area but not reported in the 2020 Research Reports.

Trial	Location	Description
Aphanomyces Seed Treatment Trial	Hector	This trial evaluated the effectiveness of a new seed treatment product to control Aphanomyces. As a proprietary trial all data was collected and delivered to the company funding the research.
Seed Treatment Trial	Wood Lake	This trial evaluated the effectiveness of seed treatment products to boost plant health and yield. 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 Seed Treatment and Post Application Trial	Renville	This trial evaluated the effectiveness of seed treatments and post applications to control rhizoctonia. As a proprietary trial all data was collected and delivered to the company funding the research.
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 1 year complete. As such, no data was published on this trial in 2020.
SES VanderHave Proprietary Trials	Hector, Wood Lake, Murdock, and Lake Lillian	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.
Hilleshog Proprietary Trials	Lake Lillian and Murdock	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.