2019
RESEARCH REPORT

Southern Minnesota Beet Sugar Cooperative

SMBSC RESEARCH VISION STATEMENT AND MISSION

- Vision Statement:
- Conduct industry leading agronomic research and sugar beet storage research that enables Shareholder's data driven decisions and empowers the Cooperative's sustainability into the future.

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

TABLE OF CONTENTS

2019 ACKNOWLEDGEMENTS

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2019 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. 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. 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, Stinger, and Select Max at the appropriate rates and times. The weeds present at each site dictated the actual 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 operation. Six, seven, or eight Cercospora leafspot fungicide applications were made at each Official Variety Trial sites.

In early September, approximately 2.5 feet was tilled under on each end of every plot to eliminate the border effect that develops on the outside of the plots near the tilled alleys, except for the Murdock trial where rainfall prevented this operation. Row lengths are taken on each harvest row to calculate yield at harvest. All plots were defoliated using a 4-row defoliator. The center two rows of each plot were harvested using a 2-row research harvester. All beets harvested from the center two rows were weighed on a scale on the harvester and a sample of beets was taken for quality analysis. At Murdock, end beets were painted so they were avoided when collection a subsample 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 Rosemount, 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. In 2019 the Wood Lake OVT site was abandoned in mid-June. Excessive rain throughout the entire spring severely affected the trial. Additionally, the 2019 BSDF Rhizoctonia Root Rot Nursery was not used for approval due to too variable disease development. 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 2020 sugar beet crop.

2019 SMBSC Official Variety Trials

Yield Trials Specifications

Trial Type	Cooperator	Trial Location	Previous Crop	Starter Fertilizer	Planting Date	Thinning Date	Harvest Date	Disease
Yield	G.E. Johnson Inc	Hector	Soybeans	No	5/7/2019	6/10/2019	9/27/2019	Light APH & RHC; Moderate CLS
Yield	Brad and Jeff Schmoll	Lake Lillian	Soybeans	No	5/6/2019	6/13/2019	10/26/2019	Moderate APH; Moderate CLS
Yield	Schwerin Farms	Wood Lake	Field Corn	No	5/17/2019	6/26/2019	n/a	
Yield	Brett Petersen	Murdock	Soybeans	Yes	6/3/2019	7/3/2019	10/17/2019	Light CLS

Disease Nursery Trials Specifications

Trial Type	Investigator	Trial Location	Rating Performed by	Use of Ratings in 2020 Variety Approval System
Aphanomyces	SMBSC	Renville	SMBSC Staff	50% of 2019 APH Rating
Aphanomyces	Betaseed	Shakopee	Betaseed, Mark Bloomquist, Cody Groen, Jason Brantner	50% of 2019 APH Rating
Cercospora	SMBSC	Renville	SMBSC Staff	50% of 2019 CLS Rating
Cercospora	Betaseed	Randolph	Betaseed	50% of 2019 CLS Rating
Rhizoctonia	SMBSC	Renville	SMBSC Staff	100% of the 2019 RHC Rating
Rhizoctonia	BSDF - USDA/ARS	Michigan	Linda Hanson and USDA/ARS Staff	Unused due to trial statistical non-signifigance

Table 1. Comparison of 2020 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Three Years of Data (2017-2019)

2020 Fully Approved Varieties - Three Years of Data (% of Mean is of Approved Mean)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Aphanomyces 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	
Beta 9475		279.3	98.6	9361.6	97.6	16.2	98.6	92.1	100.0	33.6	99.0	4.0	98.9	4.6	92.0	4.3	101.7	77.2	101.6	96.5	95.5	Beta 9475
Beta 9780	CLS	284.4	100.5	9811.6	102.3	16.5	100.3	92.3	100.2	34.6	101.9	3.9	94.8	5.1	102.0	4.3	100.1	75.1	98.9	101.8	103.8	Beta 9780
Crystal M579		285.7	100.9	9609.7	100.2	16.6	101.1	91.8	99.7	33.7	99.1	4.3	106.4	5.3	106.0	4.2	98.2	75.6	99.5	101.7	101.0	Crystal M579
Mean		**283.1**	**100.0**	**9594.3**	**100.0**	**16.4**	**100.0**	**92.1**	**100.0**	**34.0**	**100.0**	**4.1**	**100.0**	**5.0**	**100.0**	**4.3**	**100.0**	**75.9**	**100.0**	**100.0**	**100.0**	**Mean**

2020 Specialty Approved Varieties - Three Years of Data (% of mean is of Approved Mean)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Aphanomyces 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	
Crystal M509	CLS	265.7	93.8	10049.7	104.7	15.5	94.3	91.9	99.8	37.9	111.6	3.9	94.9	4.6	92.0	4.3	99.7	77.2	101.7	84.9	94.8	Crystal M509
Crystal M623	RHC	276.8	97.7	8836.7	92.1	16.1	98.1	92.0	99.9	32.1	94.4	4.3	104.7	3.3	66.0	4.3	101.3	77.0	101.3	94.6	89.4	Crystal M623
Crystal RR018	RHC	273.5	96.6	8599.0	89.6	16.0	97.4	91.5	99.4	31.3	92.1	4.5	111.0	3.5	70.0	4.7	110.0	73.2	96.4	91.4	84.2	Crystal RR018
Hilleshog 9739	CLS/RHC	265.6	93.8	8119.4	84.6	15.4	93.7	92.0	99.9	30.5	89.7	4.1	100.3	3.5	70.0	5.1	119.9	73.7	97.0	83.6	75.1	Hilleshog 9739
SV RR862	CLS	274.3	96.9	9535.3	99.4	15.9	96.7	92.2	100.1	34.8	102.6	4.0	98.6	3.8	76.0	4.5	104.4	74.5	98.1	92.1	94.4	SV RR862
SV RR863	CLS	274.7	97.0	9663.6	100.7	15.9	96.6	92.3	100.2	35.2	103.7	3.7	91.8	3.8	76.0	4.5	104.5	72.3	95.2	92.4	95.8	SV RR863

***Revenue per Ton** and **Revenue per Acre** figures were produced using the payment calculation with factors released on Nov. 28, 2018 for the 1st 2018 crop payment estimate.

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

Table 2. Comparison of 2020 Fully Approved Varieties to Test Market and Specialty Approved Varieties - Two Years of Data (2018-2019)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Aphanomyces Root Rating**		Emergence (%)		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	
2020 Fully Approved Varieties - Two Years of Data (% of Mean is of Approved Mean)																						
Beta 9475		276.1	98.8	8942.4	97.7	16.1	98.8	91.7	100.1	32.6	99.1	4.2	98.8	4.8	91.7	4.3	103.4	77.4	101.0	97.0	96.2	Beta 9475
Beta 9780	CLS	280.9	100.6	9342.5	102.1	16.4	100.4	91.9	100.3	33.4	101.6	4.1	95.9	5.3	101.3	4.1	98.6	75.5	98.6	102.5	104.1	Beta 9780
Crystal M579		281.0	100.6	9161.5	100.1	16.4	100.8	91.3	99.6	32.6	99.3	4.5	105.3	5.6	107.0	4.1	98.0	76.9	100.4	100.5	99.6	Crystal M579
Mean		**279.3**	**100.0**	**9148.8**	**100.0**	**16.3**	**100.0**	**91.6**	**100.0**	**32.9**	**100.0**	**4.2**	**100.0**	**5.2**	**100.0**	**4.1**	**100.0**	**76.6**	**100.0**	**100.0**	**100.0**	**Mean**
2020 Test Market Varieties for Limited Sales - Two Years of Data (% of mean is of Approved Mean)																						
Beta 9810	CLS	276.7	99.0	9008.7	98.5	16.2	99.5	91.2	99.5	32.9	100.2	4.1	97.6	4.2	80.3	3.0	73.2	76.4	99.7	96.9	97.0	Beta 9810
Crystal M821	CLS	276.8	99.1	8726.4	95.4	16.1	98.7	91.6	100.0	31.5	95.8	3.8	88.8	5.1	97.5	3.3	79.2	78.0	101.8	96.7	92.6	Crystal M821
Crystal M837	CLS	280.7	100.5	9088.4	99.3	16.3	99.8	91.6	100.0	32.6	99.1	3.9	92.9	4.7	89.8	3.8	91.3	72.0	94.0	99.9	99.0	Crystal M837
Maribo MA801	CLS	268.3	96.1	7592.8	83.0	15.6	95.6	91.6	100.0	28.3	86.2	3.7	87.6	4.6	87.9	5.0	119.8	79.8	104.2	88.6	76.3	Maribo MA801
SV 881	CLS	271.1	97.1	9123.3	99.7	15.6	95.9	92.1	100.5	33.7	102.6	3.8	90.5	3.8	72.6	4.4	105.8	75.1	98.1	90.2	92.5	SV 881
SV 883		271.9	97.3	9000.5	98.4	15.8	96.6	91.7	100.1	33.2	100.9	4.2	98.8	3.6	68.8	4.3	104.0	75.1	98.1	92.2	93.1	SV 883
2020 Specialty Approved Varieties - Two Years of Data (% of mean is of Approved Mean)																						
Crystal M509	CLS	261.3	93.5	9745.1	106.5	15.4	94.1	91.4	99.8	37.5	114.0	4.1	95.9	4.9	93.6	4.2	100.4	80.4	105.0	84.7	96.6	Crystal M509
Crystal M623	RHC	270.0	96.7	8351.9	91.3	15.9	97.5	91.3	99.7	31.2	94.8	4.4	104.1	3.4	65.0	4.1	98.6	78.8	102.9	92.4	87.7	Crystal M623
Crystal RR018	RHC	267.9	95.9	7956.9	87.0	15.8	97.0	90.8	99.2	29.5	89.7	4.7	110.1	3.7	70.7	4.4	106.5	72.2	94.2	89.2	80.0	Crystal RR018
Hilleshog 2219	CLS	277.3	99.3	8025.3	87.7	16.0	98.3	91.9	100.3	29.1	88.5	4.0	94.7	3.4	65.0	4.9	117.9	72.7	95.0	96.1	85.0	Hilleshog 2219
Hilleshog 9739	CLS/RHC	262.2	93.9	7867.7	86.0	15.2	93.4	91.6	100.0	29.8	90.7	4.1	97.0	3.3	63.1	5.0	119.8	75.2	98.3	82.2	74.5	Hilleshog 9739
SV RR862	CLS	270.4	96.8	9089.3	99.3	15.7	96.4	91.7	100.2	33.7	102.5	3.8	89.3	3.7	70.7	4.3	103.4	77.8	101.5	90.6	92.8	SV RR862
SV RR863	CLS	269.5	96.5	9103.0	99.5	15.7	96.1	91.7	100.1	33.9	103.0	3.8	88.8	3.8	72.6	4.3	103.4	73.9	96.5	90.6	93.4	SV RR863

*__Revenue per Ton__ and **Revenue per Acre** figures were produced using the payment calculation with factors released on Nov. 28, 2018 for the 1st 2018 crop payment estimate.

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

Table 3. Comparison of 2020 Fully Approved Varieties to Test Market and Specialty Approved Varieties - 1 Year Data (2019)

		Rec/T (lbs)		Rec/A (lbs)		Sugar %		Purity (%)		Yield (T/A)		Cercospora Leaf Spot**		Rhizoctonia Root Rating**		Aphanomyces 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	
2020 Fully Approved Varieties - One Year of Data (% of Mean is of Approved Mean)																						
Beta 9475		291.4	99.6	8485.0	96.7	16.8	99.8	92.7	100.1	29.1	97.2	4.1	99.2	4.9	84.5	4.4	104.8	82.2	102.1	99.7	96.9	Beta 9475
Beta 9780	CLS	293.6	100.4	8861.2	101.0	16.8	99.8	93.0	100.4	30.2	100.9	4.0	96.8	5.8	100.0	4.0	95.2	80.5	100.0	100.6	101.5	Beta 9780
Crystal M579		292.4	100.0	8967.8	102.2	16.9	100.4	92.2	99.5	30.5	101.9	4.3	104.0	6.7	115.5	4.2	100.0	78.9	98.0	99.6	101.5	Crystal M579
Mean		**292.5**	**100.0**	**8771.3**	**100.0**	**16.8**	**100.0**	**92.6**	**100.0**	**29.9**	**100.0**	**4.1**	**100.0**	**5.8**	**100.0**	**4.2**	**100.0**	**80.5**	**100.0**	**100.0**	**100.0**	**Mean**
2020 Test Market Varieties - One Year of Data (% of mean is of Approved Mean)																						
Beta 9810	CLS	289.1	98.8	8646.0	98.6	16.8	99.8	92.3	99.6	30.4	101.6	4.1	99.2	4.0	69.0	3.4	79.8	79.7	99.0	98.5	100.0	Beta 9810
Crystal M821	CLS	288.8	98.7	8500.6	96.9	16.7	99.2	92.5	99.9	29.4	98.2	3.7	89.5	6.2	106.9	3.5	83.3	81.5	101.2	97.6	95.9	Crystal M821
Crystal M837	CLS	294.5	100.7	8383.8	95.6	16.9	100.4	92.7	100.1	28.5	95.2	3.9	94.4	5.1	87.9	3.9	91.7	76.3	94.7	101.2	96.3	Crystal M837
Hilleshog 2327		282.5	96.6	9177.4	104.6	16.3	96.8	93.1	100.5	32.4	108.2	3.8	90.7	3.5	60.3	4.7	110.7	77.6	96.4	93.6	101.3	Hilleshog 2327
Maribo MA801	CLS	283.2	96.8	7222.7	82.3	16.3	96.8	92.8	100.2	25.3	84.5	3.7	88.3	4.6	79.3	5.2	122.6	84.9	105.4	92.7	78.4	Maribo MA801
SV 881	CLS	280.7	96.0	8739.8	99.6	16.1	95.6	93.0	100.4	31.1	103.9	3.7	89.5	3.3	56.9	4.6	108.3	79.9	99.2	90.4	93.9	SV 881
SV 883		279.7	95.6	8603.8	98.1	16.2	96.2	92.5	99.9	30.8	102.9	4.0	96.8	3.0	51.7	4.5	106.0	76.8	95.4	90.4	93.0	SV 883
2020 Specialty Approved Varieties - One Year of Data (% of mean is of Approved Mean)																						
Crystal M509	CLS	272.6	93.2	9241.5	105.4	15.9	94.5	92.4	99.7	33.9	113.3	4.0	96.8	5.2	89.7	4.5	106.0	82.3	102.2	85.7	97.1	Crystal M509
Crystal M623	RHC	283.9	97.1	7937.1	90.5	16.5	98.0	92.3	99.6	28.1	93.9	4.3	104.0	2.8	48.3	4.3	102.4	76.8	95.4	94.1	88.4	Crystal M623
Crystal RR018	RHC	283.6	97.0	7767.0	88.5	16.4	97.4	92.1	99.4	26.6	88.9	4.6	111.3	3.3	56.9	4.8	114.3	73.9	91.8	92.1	81.8	Crystal RR018
Hilleshog 2219	CLS	291.5	99.7	7522.5	85.8	16.6	98.6	93.2	100.6	25.8	86.2	3.9	94.4	2.6	44.8	4.8	114.3	71.4	88.7	98.3	84.7	Hilleshog 2219
Hilleshog 9739	RHC/CLS	271.3	92.8	7369.8	84.0	15.7	93.3	92.6	100.0	27.0	90.2	4.1	98.0	2.3	39.7	5.0	117.9	77.1	95.7	83.4	75.2	Hilleshog 9739
SV RR862	CLS	282.0	96.4	8726.7	99.5	16.3	96.8	92.5	99.9	30.9	103.2	3.8	90.7	2.9	50.0	4.5	106.0	80.8	100.3	91.8	94.8	SV RR862
SV RR863	CLS	281.8	96.4	9030.3	103.0	16.2	96.2	92.9	100.3	32.1	107.2	3.7	89.5	3.3	56.9	4.3	101.2	79.0	98.1	91.6	98.2	SV RR863

*__Revenue per Ton__ and __Revenue per Acre__ figures were produced using the payment calculation with factors released on Nov. 28, 2018 for the 1st 2018 crop payment estimate.

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

2017 - 2019 Disease Nursery Data for Rhizoctonia, Aphanomyces, and Cercospora

** 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.

	Rhizoctonia Root Ratings					Aphanomyces Root Ratings					Cercospora Leafspot Ratings				
Variety Description	2019 Root Rating	2018 Root Rating	2017 Root Rating	2018-2019 2 Year Mean Root Rating	2017-2019 3 Year Mean Root Rating	2019 Root Rating	2018 Root Rating	2017 Root Rating	2018-2019 2 Year Mean Root Rating	2017-2019 3 Year Mean Root Rating	2019 CLS Rating	2018 CLS Rating	2017 CLS Rating	2018-2019 2 Year Mean Foliar Rating	2017-2019 3 Year Mean Foliar Rating
Fully Approved Varieties															
Beta 9475	4.9	4.6	4.2	4.8	4.6	4.4	4.2	4.5	4.3	4.3	4.1	4.3	3.7	4.2	4.0
Beta 9780 (CLS)	5.8	4.7	4.7	5.3	5.1	4.0	4.2	4.7	4.1	4.3	4.0	4.1	3.5	4.1	3.9
Crystal M579	6.7	4.4	4.8	5.6	5.3	4.2	3.9	4.5	4.1	4.2	4.3	4.6	4.1	4.5	4.3
Test Market Varieties															
Beta 9810 (CLS)	4.0	4.3		4.2		3.4	2.7		3.0		4.1	4.2		4.1	
Crystal M821 (CLS)	6.2	4.0		5.1		3.5	3.1		3.3		3.7	3.8		3.8	
Crystal M837 (CLS)	5.1	4.3		4.7		3.9	3.7		3.8		3.9	4.0		3.9	
Hilleshog 2327	3.5					4.7					3.8				
Maribo MA801 (CLS)	4.6	4.6		4.6		5.2	4.8		5.0		3.7	3.8		3.7	
SV 881 (CLS)	3.3	4.3		3.8		4.6	4.2		4.4		3.7	4.0		3.8	
SV 883	3.0	4.2		3.6		4.5	4.2		4.3		4.0	4.4		4.2	
RHC Specialty Approved															
Crystal RR018 (RHC)	3.3	4.0	3.3	3.7	3.5	4.8	4.0	5.3	4.4	4.7	4.6	4.7	4.2	4.7	4.5
Crystal M623 (RHC)	2.8	3.9	3.2	3.4	3.3	4.3	3.9	4.8	4.1	4.3	4.3	4.5	4.0	4.4	4.3
Hilleshog 9739 (CLS/RHC)	2.3	4.3	3.9	3.3	3.5	5.0	5.0	5.5	5.0	5.1	4.1	4.2	4.0	4.1	4.1
CLS Specialty Approved															
Crystal M509 (CLS)	5.2	4.5	4.0	4.9	4.6	4.5	3.9	4.5	4.2	4.3	4.0	4.1	3.5	4.1	3.9
Hilleshog 2219 (CLS)	2.6	4.1		3.4		4.8	5.0		4.9		3.9	4.1		4.0	
SV RR862 (CLS)	2.9	4.4	4.0	3.7	3.8	4.5	4.1	4.8	4.3	4.5	3.8	3.8	4.5	3.8	4.0
SV RR863 (CLS)	3.3	4.3	3.8	3.8	3.8	4.3	4.3	4.8	4.3	4.5	3.7	3.8	3.7	3.8	3.7
	Rhizoctonia Ratings from SMBSC Nursery at Renville					Aphanomyces Ratings from SMBSC Nursery at Renville					Cercospora Ratings from SMBSC Nursery in Renville				
	and BSDF Nursery in Michigan					and Betaseed Nursery in Shakopee.					and Betaseed Nursery near Randolph MN.				
	Ratings are on scale of 1 - 7. (1 = Healthy, 7 = Dead)					**Ratings are on scale of 1 - 9. (1 = Healthy, 9 = Dead)**					**Ratings are on scale of 1-9. 1 = Clean leaves, 9 = Dead Leaves.**				

SMBSC Agricultural Staff Variety Strip Trial - Summary

Variety	Stand Count 28 DAP Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Acre	Percent of Mean Revenue per Acre
Beta 9780	190	15.9	92.0	23.3	6377.7	113.1%
Crystal M623	186	15.4	91.2	23.1	6055.7	100.7%
Hill 2219	166	15.3	91.7	19.2	5062.1	80.4%
Hill 9865	177	15.2	91.7	21.3	5521.0	91.3%
SV 863	185	15.3	92.3	24.3	6407.9	108.5%
SV 881	198	15.4	91.8	24.1	6366.0	106.0%
Mean	184	15.4	91.8	22.6	5965.1	100.0
%CV	8	1.7	0.9	9.2	9.5	11.2
PR>F	<0.0001	0.0004	0.2265	0.0004	0.0003	<0.0001
LSD (0.05)	16	0.3	NS	2.3	618.8	12.3
Reps	7	7	7	7	7	7

Combined data from 7 locations with each location considered a replicate.
Locations: Renville, Hector, Olivia, Belgrade, Raymond, Maynard, and Bird Island.
Revenue is calculated using the 2018 crop payment calculator, utilizing values released Nov. 28, 2018

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	189	16.3	91.7	14.1	279.2	3945.8	116.8%	Beta 9780
Crystal M623	176	16.0	91.4	14.9	271.7	4051.8	115.0%	Crystal M623
Hilleshog 2219	155	16.0	90.9	8.0	270.6	2161.0	61.0%	Hilleshog 2219
Hilleshog 9865	190	16.0	91.7	12.2	272.8	3339.7	95.5%	Hilleshog 9865
SV 863	189	15.8	91.1	14.5	267.3	3863.0	106.8%	SV 863
SV 881	201	15.8	91.5	14.0	268.7	3763.5	105.0%	SV 881
Hilleshog 2326*	170	15.7	91.4	9.0	267.1	2396.0	66.2%	Hilleshog 2326*
Hilleshog 2329*	173	16.0	91.3	12.1	272.6	3305.8	94.3%	Hilleshog 2329*
Average	**183**	**16.0**	**91.4**	**13.0**	**271.7**	**3520.8**	**100.0%**	**Average**

Planted: June 3, 2019

Harvested: October 6, 2019

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	219	16.7	92.9	25.5	289.8	7399.0	116.1%	Beta 9780
Crystal M623	221	15.8	91.6	24.2	268.6	6504.4	91.2%	Crystal M623
Hilleshog 2219	223	15.9	92.8	25.1	276.0	6937.9	101.6%	Hilleshog 2219
Hilleshog 9865	224	15.3	91.9	21.0	260.8	5485.0	73.2%	Hilleshog 9865
SV 863	244	15.6	93.4	25.7	273.1	7007.8	100.9%	SV 863
SV 881	246	16.1	93.5	27.4	282.2	7736.9	117.0%	SV 881
Hilleshog 9739*	223	15.6	93.4	23.6	272.7	6429.3	92.4%	Hilleshog 9739*
Hilleshog 2326*	226	15.5	92.6	22.7	268.3	6081.7	85.1%	Hilleshog 2326*
Hilleshog 2329*	224	16.0	92.9	20.4	277.6	5672.1	83.7%	Hilleshog 2329*
Average	**229**	**15.9**	**92.7**	**24.8**	**275.1**	**6845.2**	**100.0%**	**Average**

Planted: May 7, 2019

Harvested: October 15, 2019

Agriculturalist - Pete Caspers

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

SMBSC Variety Strip Trial - Olivia

Variety	28 DAP Stand Beets/100' row	Sugar %	Purity %	Tons / Acre	Extractable Sugar per Ton	Extractable Sugar per Acre	Percent Rev/Acre	Variety
Beta 9780	176	16.5	91.8	32.7	283.4	9278.1	102.4%	Beta 9780
Crystal M623	158	16.7	92.3	31.3	288.2	9018.0	101.9%	Crystal M623
Hilleshog 2219	128	16.5	92.3	31.6	285.5	9015.5	100.5%	Hilleshog 2219
Hilleshog 9865	151	16.3	92.3	30.2	281.2	8493.0	92.7%	Hilleshog 9865
SV 863	163	16.1	92.5	34.8	278.2	9676.8	103.9%	SV 863
SV 881	153	16.2	92.6	32.1	281.3	9029.1	98.6%	SV 881
Crystal M509*	174	15.8	92.5	37.7	273.0	10301.8	107.5%	Crystal M509
Average	**155**	**16.4**	**92.3**	**32.1**	**283.0**	**9085.1**	**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	220	14.8	93.1	29.6	255.7	7565.2	114.8%	Beta 9780
Crystal M623	214	14.3	92.0	30.7	243.1	7467.0	102.3%	Crystal M623
Hilleshog 2219	201	14.3	92.9	25.3	246.7	6240.2	88.2%	Hilleshog 2219
Hilleshog 9865	198	14.4	92.0	26.8	245.1	6568.5	91.6%	Hilleshog 9865
SV 863	225	14.5	92.7	27.3	248.7	6793.7	97.6%	SV 863
SV 881	238	14.4	92.9	29.5	248.6	7340.9	105.5%	SV 881
Beta 9475*	220	14.5	93.1	30.6	251.1	7678.6	112.5%	Beta 9475*
Crystal M509*	224	14.1	92.6	32.9	242.0	7950.3	107.8%	Crystal M509*
Average	216	14.4	92.6	28.2	248.0	6995.9	100.0%	**Average**

Planted: April 25, 2019

Harvested: October 8, 2019

Agriculturalist: Jared Kelm

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

**Denotes an irrigated strip trial

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	150	16.4	91.8	28.0	280.6	7869.6	125.7%	Beta 9780
Crystal M623	120	15.2	89.6	30.0	251.6	7539.2	100.3%	Crystal M623
Hilleshog 2219	63	15.2	91.2	17.0	258.2	4378.8	61.1%	Hilleshog 2219
Hilleshog 9865	110	15.1	90.3	25.6	253.1	6468.3	87.0%	Hilleshog 9865
SV 863	99	15.0	92.0	32.0	256.9	8229.2	113.8%	SV 863
SV 881	131	15.3	92.5	29.4	263.5	7743.4	112.0%	SV 881
Crystal M380*	124	15.5	91.7	22.4	265.2	5941.7	86.9%	Crystal M380*
Average	**112**	**15.4**	**91.2**	**27.0**	**260.7**	**7038.1**	**100.0%**	**Average**

Planted: May 17, 2019

Harvested: September 28, 2019

Agriculturalist: Bill Luepke

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

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	175	14.8	91.7	13.6	250.9	3411.7	105.1%	Beta 9780
Crystal M623	223	14.8	90.8	13.5	248.7	3365.2	101.9%	Crystal M623
Hilleshog 2219	200	14.3	90.8	11.4	240.4	2747.2	77.4%	Hilleshog 2219
Hilleshog 9865	186	14.3	91.8	14.0	243.8	3417.0	99.3%	Hilleshog 9865
SV 863	185	14.8	92.6	15.0	255.5	3830.5	122.2%	SV 863
SV 881	206	14.5	88.3	15.0	234.9	3524.2	94.0%	SV 881
Average	**196**	**14.6**	**91.0**	**13.8**	**245.7**	**3382.6**	**100.0%**	**Average**

Planted: June 7, 2019

Harvested: September 25, 2019

Agriculturalist: Austin Neubauer

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	201	15.6	91.1	19.7	263.2	5174.8	110.8%	Beta 9780
Crystal M623	190	15.4	90.4	17.2	258.0	4444.4	91.9%	Crystal M623
Hilleshog 2219	194	14.5	91.1	16.2	244.0	3953.9	73.2%	Hilleshog 2219
Hilleshog 9865	181	15.0	92.2	19.0	256.4	4875.4	99.7%	Hilleshog 9865
SV 863	191	15.3	91.6	21.0	259.9	5454.3	114.2%	SV 863
SV 881	209	15.1	91.3	21.2	255.4	5424.1	110.1%	SV 881
Average	**194**	**15.1**	**91.3**	**19.1**	**256.2**	**4887.8**	**100.0%**	**Average**

Planted: May 7, 2019
Harvested: September 28, 2019
Agriculturalist: Les Plumley

2019 Hector OVT Results - Identified

			Tons		Sugar		ES		EST		ESA		Nitrate		Emergence		Purity	
Entry No.	Entry Name	Label	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct
1	SV RR875	A	27.8	97.2	15.3	99.3	13.2	98.8	264.8	98.8	7348.6	95.9	2.7	58.3	62	79.8	92.7	99.6
2	BTS 9967	B	29.7	103.8	15.8	102.6	13.7	102.1	273.8	102.1	8128.0	106.1	2.7	58.3	79.6	102.5	92.6	99.5
3	BTS 9810	C	27.6	96.5	16.0	103.5	13.7	102.5	274.7	102.5	7516.1	98.1	5.8	127.2	79.2	101.9	92.2	99.0
4	BTS 9902	D	30.1	105.4	15.9	103.3	13.8	102.8	275.6	102.8	8278.8	108.1	5.7	123.9	85.2	109.6	92.6	99.5
5	BTS 9928	E	27.2	94.9	16.1	104.2	14.0	104.2	279.2	104.2	7553.5	98.6	2.3	51.0	79.2	101.9	92.8	99.7
6	BTS 9944	F	32.4	113.3	15.1	97.6	13.2	98.3	263.5	98.3	8527.7	111.3	4.3	94.7	81.0	104.3	93.8	100.7
7	Crystal M821	G	27.8	97.1	15.7	101.5	13.4	100.2	268.6	100.2	7457.2	97.3	3.0	65.6	81.9	105.5	92.1	98.9
8	SV 893	H	27.8	97.2	15.9	103.1	13.9	103.5	277.3	103.5	7712.6	100.7	2.7	58.3	75.0	96.5	93.2	100.1
9	HIL2219	I	28.1	98.2	15.0	97.4	13.1	97.5	261.2	97.5	7332.9	95.7	2.7	58.3	75.5	97.1	93.3	100.2
10	Crystal M978	J	28.4	99.2	15.7	101.4	13.4	100.1	268.2	100.1	7610.0	99.3	2.3	51.0	83.8	107.8	92.0	98.8
11	Baseline 9a SV RR863	K	30.0	104.8	15.5	100.7	13.5	101.1	270.9	101.1	8117.2	106.0	5.0	109.3	83.8	107.8	93.3	100.3
12	HIL9739	L	27.6	96.4	14.6	94.7	12.7	94.5	253.3	94.5	6970.5	91.0	3.7	80.2	74.5	95.9	93.2	100.1
13	Crystal M951	M	34.0	119.0	14.6	94.4	12.7	94.8	254.0	94.8	8639.9	112.8	5.7	123.9	76.4	98.3	93.7	100.7
14	SV 897	N	27.8	97.3	15.4	100.0	13.3	98.9	265.1	98.9	7548.2	98.5	5.3	115.5	77.8	100.1	92.3	99.1
15	Crystal M837	O	29.7	104.0	16.3	105.8	14.2	106.1	284.3	106.1	8458.4	110.4	5.3	116.6	79.6	102.5	93.0	99.9
16	SV 883	P	29.1	101.8	15.5	100.5	13.4	100.0	268.1	100.0	7791.9	101.7	5.7	123.9	71.8	92.4	92.7	99.6
17	HIL2326	Q	24.6	86.0	14.8	96.2	13.0	96.7	259.2	96.7	6367.9	83.1	3.3	72.9	85.7	110.2	93.7	100.6
18	Baseline 6a Crystal RR265	R	28.6	100.0	15.4	99.5	13.3	99.4	266.4	99.4	7610.1	99.3	5.0	109.3	72.2	93.0	93.0	99.9
19	SV 881	S	29.5	103.3	15.3	99.0	13.4	99.6	267.1	99.6	7881.6	102.9	4.0	87.4	80.1	103.1	93.6	100.6
20	Crystal M942	T	27.2	95.1	15.1	97.8	13.2	98.7	264.6	98.7	7200.9	94.0	2.7	58.3	75.0	96.5	93.9	100.9
21	HIL2329	U	25.8	90.1	15.5	100.1	13.4	100.1	268.2	100.1	6902.1	90.1	4.3	94.7	79.6	102.5	93.0	99.9
22	HIL2327	V	30.1	105.2	15.2	98.5	13.3	99.2	265.8	99.2	7993.1	104.3	2.0	43.7	77.8	100.1	93.7	100.6
23	Crystal M509	W	33.0	115.5	15.1	97.8	13.1	97.5	261.4	97.5	8633.1	112.7	14.3	313.3	78.7	101.3	93.0	99.9
24	HIL2328	X	23.8	83.3	15.4	99.9	13.1	97.4	261.1	97.4	6257.6	81.7	2.8	61.6	75.5	97.1	91.3	98.1
25	SV RR862	Y	30.7	107.2	15.4	99.8	13.3	99.5	266.8	99.5	8179.7	106.8	12.7	276.9	79.2	101.9	92.9	99.8
26	Crystal M998	Z	30.1	105.2	15.6	100.8	13.6	101.7	272.5	101.7	8202.3	107.1	2.7	58.3	77.3	99.5	93.7	100.6
27	Baseline 8a Hilleshog 9093RR	AA	28.2	98.4	14.9	96.4	12.6	94.0	251.9	94.0	7101.0	92.7	3.0	65.6	69.4	89.4	91.4	98.1
28	BTS 9780	AB	29.2	102.2	16.0	103.9	14.0	104.3	279.6	104.3	8165.2	106.6	2.7	58.3	79.2	101.9	93.2	100.1
29	SV 895	AC	29.6	103.6	15.6	100.8	13.6	101.1	270.9	101.1	8038.9	104.9	9.0	196.7	83.8	107.8	93.2	100.1
30	SV 894	AD	28.1	98.4	15.5	100.6	13.5	101.0	270.6	101.0	7618.8	99.5	4.0	87.4	78.7	101.3	93.3	100.2
31	BTS 9986	AE	31.9	111.7	14.9	96.9	13.1	97.5	261.3	97.5	8335.0	108.8	3.0	65.6	82.4	106.1	93.7	100.7
32	SV 892	AF	30.7	107.3	15.2	98.5	13.3	99.3	266.2	99.3	8167.1	106.6	3.3	72.9	71.8	92.4	93.8	100.7
33	SV RR876	AG	27.3	95.6	15.8	102.2	13.8	103.3	276.9	103.3	7569.4	98.8	3.3	72.9	79.6	102.5	93.8	100.7
34	SV 896	AH	29.1	101.8	15.3	99.0	13.3	99.3	266.0	99.3	7738.9	101.0	2.7	58.3	68.1	87.6	93.3	100.3
35	Baseline 7a Hilleshog 4017RR	AI	23.0	80.5	15.2	98.3	13.2	98.3	263.5	98.3	6072.7	79.3	6.0	131.2	77.3	99.5	93.2	100.1
36	Crystal RR018	AJ	26.2	91.7	15.4	100.0	13.4	100.2	268.5	100.2	7043.7	92.0	4.7	102.0	75.0	96.5	93.2	100.1
37	MA801	AK	25.4	88.6	14.8	95.7	12.9	96.4	258.2	96.3	6556.9	85.6	4.3	94.7	83.8	107.8	93.8	100.7
38	Crystal M623	AL	26.6	92.8	15.9	103.0	13.8	102.7	275.3	102.7	7182.4	93.8	2.4	52.5	78.2	100.7	92.8	99.6
39	BTS 9475	AM	30.5	106.8	15.8	102.2	13.6	101.8	272.8	101.8	8320.7	108.6	2.0	43.7	79.2	101.9	92.7	99.5
40	MA907	AN	25.4	88.8	15.2	98.3	13.1	97.6	261.7	97.6	6632.5	86.6	4.0	87.4	77.8	100.1	92.6	99.5
41	Crystal M977	AO	31.1	108.6	15.3	99.2	13.4	99.6	267.1	99.7	8301.1	108.4	2.7	58.3	76.9	98.9	93.5	100.4
42	Crystal M579	AP	27.3	95.4	16.5	107.2	14.3	106.8	286.3	106.8	7811.9	102.0	3.0	65.6	80.1	103.1	92.5	99.4
43	BTS 9952	AQ	30.4	106.1	15.1	97.5	13.3	99.3	266.2	99.3	8083.4	105.5	8.0	174.9	73.2	94.1	94.6	101.6
44	BTS 9916	AR	31.7	110.8	15.0	97.5	13.2	98.6	264.3	98.6	8249.9	107.7	5.8	127.2	85.7	110.2	94.1	101.0
45	MA908	AS	30.6	107.0	15.3	99.1	13.2	98.3	263.6	98.3	8063.0	105.3	19.7	429.9	81.9	105.5	92.6	99.4
46	MA910	AT	24.1	84.2	15.7	102.0	13.4	100.2	268.6	100.2	6474.0	84.5	3.7	80.2	77.8	100.1	91.7	98.4
47	MA909	AU	29.0	101.4	15.2	98.3	13.4	100.0	268.0	100.0	7762.4	101.3	4.0	87.4	63.0	81.0	94.5	101.5
48	SV RR863	AV	29.4	102.7	15.2	98.7	13.4	99.9	267.9	99.9	7868.7	102.7	2.3	51.0	81.0	104.3	94.1	101.0
49	BTS 9935	AW	28.2	98.5	16.2	105.2	14.1	105.5	282.8	105.5	7973.0	104.1	2.0	43.7	76.4	98.3	93.1	100.0
		GRAND MEAN	28.6		15.4		13.4		268		7660.2		4.6		77.7		93.1	
		CV	5.4		2.5		3.1		3.1		6		137.3		7.5		1.1	
		Error d.f.	96		91		91		91		91		91		96		91	
		LSD	2.5		0.5		0.7		13.3		731.9		10.1		9.4		1.6	
		Alpha level	0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
		Max. Mean	34		16.5		14.3		286.3		8639.8		19.7		85.7		94.6	
		Max. Plot	35.4		16.8		14.9		297.4		9195.9		53		93.1		95.7	
		Min. Mean	23		14.6		12.6		251.9		6072.7		2		62		91.3	
		Min. Plot	20.9		13.4		11.9		237.5		5359.8		1		50		89.7	
		No. of Reps	3		3		3		3		3		3		3		3	
		Rep-Msqr	50.1		2.4		2		796.8		1374973.5		23.4		85.8		0.1	
		Residual	2.4		0.1		0.2		69.2		209185		39.5		34.3		1	
		RE-RCBD	100		100		100		100		100		100		100		100	

2019 Lake Lillian OVT Results - Identified

			Tons		Sugar		ES		EST		ESA		Nitrate		Emergence		Purity	
Entry No.	Entry Name	Label	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct
1	SV RR875	A	35.1	101.6	16.6	99.6	14.4	99.3	287.7	99.3	9901.5	99.0	7.4	67.5	72.7	94.7	92.6	99.7
2	BTS 9967	B	35.1	101.5	17.2	103.0	14.8	101.8	295.2	101.8	10340.6	103.4	10.5	96.0	75.2	97.9	92.0	99.0
3	BTS 9810	C	36.3	105.2	16.8	100.9	14.6	100.4	291.1	100.4	10307.5	103.0	10.9	100.1	78.6	102.4	92.5	99.6
4	BTS 9902	D	35.3	102.0	17.5	104.8	15.2	105.1	304.6	105.1	10788.1	107.8	7.5	68.8	79.3	103.3	92.9	100.0
5	BTS 9928	E	34.4	99.4	17.1	102.6	15.0	103.2	299.2	103.2	10294.0	102.9	7.6	69.4	79.6	103.6	93.2	100.4
6	BTS 9944	F	39.7	114.8	15.9	95.7	14.1	97.0	281.0	97.0	11096.8	110.9	14.8	136.1	78.8	102.5	94.0	101.2
7	Crystal M821	G	34.8	100.7	16.9	101.6	14.7	101.5	294.3	101.5	10219.0	102.1	7.8	71.8	83.3	108.4	92.8	99.9
8	SV 893	H	35.2	101.8	16.3	98.1	14.3	98.4	285.2	98.4	10037.8	100.3	8.2	74.9	71.0	92.5	93.2	100.3
9	HIL2219	I	30.3	87.6	17.2	103.4	15.1	104.4	302.6	104.4	9179.1	91.8	10.5	96.3	65.7	85.5	93.5	100.7
10	Crystal M978	J	35.5	102.7	16.6	99.4	14.4	99.4	288.0	99.4	10112.3	101.1	8.9	81.6	78.5	102.2	92.9	100.0
11	Baseline 9a SV RR863	K	35.3	102.2	16.6	99.9	14.6	100.4	291.0	100.4	10280.6	102.8	6.5	59.6	76.3	99.3	93.3	100.4
12	HIL9739	L	33.7	97.4	16.5	98.9	14.5	99.8	289.2	99.8	9730.1	97.3	8.2	74.9	74.5	97.0	93.5	100.7
13	Crystal M951	M	38.2	110.5	16.2	97.5	14.2	98.1	284.3	98.1	10901.8	109.0	17.2	157.5	78.6	102.3	93.5	100.7
14	SV 897	N	35.7	103.3	16.5	99.3	14.1	97.5	282.5	97.5	10116.5	101.1	8.5	78.0	77.2	100.5	91.5	98.6
15	Crystal M837	O	32.5	93.9	17.1	102.4	14.9	102.7	297.7	102.7	9650.4	96.5	7.2	65.7	73.8	96.1	93.0	100.2
16	SV 883	P	36.3	104.9	16.3	97.9	14.2	97.7	283.2	97.7	10223.1	102.2	7.2	65.7	74.3	96.7	92.8	99.9
17	HIL2326	Q	31.8	92.1	16.1	96.4	13.9	95.5	276.9	95.5	8835.0	88.3	13.5	123.8	82.3	107.2	92.4	99.4
18	Baseline 6a Crystal RR265	R	35.7	103.3	16.3	97.6	14.1	97.4	282.2	97.4	10101.7	101.0	16.3	149.8	75.0	97.7	92.8	99.9
19	SV 881	S	37.1	107.2	16.5	99.0	14.3	98.8	286.3	98.8	10615.7	106.1	5.5	50.4	80.4	104.6	92.8	99.9
20	Crystal M942	T	31.8	91.9	16.4	98.3	14.2	98.0	284.2	98.0	8968.7	89.6	8.7	79.5	71.8	93.4	92.8	99.9
21	HIL2329	U	29.5	85.4	17.0	101.9	14.7	101.6	294.6	101.6	8664.7	86.6	11.2	102.4	78.6	102.3	92.6	99.7
22	HIL2327	V	38.0	109.8	16.9	101.2	14.8	101.8	295.0	101.8	11157.6	111.5	6.3	58.1	76.9	100.1	93.3	100.4
23	Crystal M509	W	40.9	118.4	16.1	96.6	14.0	96.3	279.1	96.3	11340.8	113.4	11.0	100.9	82.7	107.6	92.8	99.9
24	HIL2328	X	29.3	84.6	17.4	104.6	15.1	103.9	301.0	103.9	8784.3	87.8	5.2	47.4	76.3	99.3	92.2	99.2
25	SV RR862	Y	34.8	100.8	16.5	98.8	14.3	98.7	286.0	98.7	9971.1	99.7	9.2	84.1	78.1	101.6	92.8	100.0
26	Crystal M998	Z	35.8	103.6	16.8	100.7	14.7	101.6	294.4	101.6	10443.8	104.4	8.3	76.4	75.7	98.6	93.5	100.6
27	Baseline 8a Hilleshog 9093RR	AA	34.2	98.8	15.8	94.7	13.5	93.2	270.2	93.2	9239.7	92.4	10.7	97.8	75.3	98.0	91.9	99.0
28	BTS 9780	AB	35.0	101.3	17.2	103.2	15.1	104.4	302.7	104.4	10621.0	106.2	16.7	152.9	75.8	98.6	93.7	100.8
29	SV 895	AC	34.1	98.6	17.0	101.9	14.8	102.4	296.7	102.4	10137.3	101.3	7.3	67.3	81.1	105.6	93.2	100.3
30	SV 894	AD	37.1	107.5	16.6	99.8	14.6	100.6	291.5	100.6	10833.8	108.3	7.8	71.8	73.3	95.4	93.5	100.6
31	BTS 9986	AE	35.7	103.4	16.4	98.2	14.3	98.6	285.8	98.6	10238.9	102.3	12.3	113.1	81.7	106.4	93.3	100.4
32	SV 892	AF	35.8	103.6	16.4	98.6	14.3	98.8	286.4	98.8	10293.0	102.9	8.5	78.0	73.9	96.2	93.1	100.2
33	SV RR876	AG	35.4	102.5	16.7	100.1	14.5	100.1	290.3	100.2	10241.9	102.4	9.1	83.6	80.7	105.0	92.9	100.0
34	SV 896	AH	35.5	102.8	16.3	97.9	14.3	98.4	285.1	98.4	10124.5	101.2	5.5	50.4	79.4	103.3	93.3	100.5
35	Baseline 7a Hilleshog 4017RR	AI	29.7	85.8	16.4	98.2	14.2	97.8	283.5	97.8	8391.1	83.9	14.0	128.4	74.7	97.3	92.6	99.7
36	Crystal RR018	AJ	31.2	90.3	17.0	102.2	14.9	103.1	298.7	103.1	9678.6	96.7	33.7	308.8	71.6	93.2	93.4	100.5
37	MA801	AK	29.4	85.2	17.0	102.0	14.7	101.7	294.7	101.7	8737.2	87.3	23.7	217.1	82.7	107.6	92.6	99.7
38	Crystal M623	AL	33.7	97.5	16.5	99.2	14.2	98.1	284.3	98.1	9533.1	95.3	38.2	350.1	74.8	97.4	92.1	99.1
39	BTS 9475	AM	33.3	96.2	17.0	102.3	14.9	102.5	297.1	102.5	9885.1	98.8	6.8	62.7	79.3	103.2	92.9	100.1
40	MA907	AN	30.7	88.8	16.8	100.9	14.6	100.6	291.6	100.6	8973.1	89.7	9.0	82.5	78.7	102.5	92.6	99.7
41	Crystal M977	AO	39.5	114.2	16.7	100.1	14.8	101.8	294.9	101.7	11668.0	116.6	9.8	90.2	74.5	97.0	94.1	101.3
42	Crystal M579	AP	35.1	101.7	17.1	102.8	14.9	103.0	298.5	103.0	10542.1	105.4	9.3	85.6	76.9	100.1	92.9	100.0
43	BTS 9952	AQ	35.6	103.1	16.4	98.4	14.0	96.8	280.6	96.8	10085.9	100.8	7.1	64.9	73.4	95.6	91.7	98.7
44	BTS 9916	AR	38.7	111.9	16.6	99.7	14.6	101.0	292.8	101.0	11325.3	113.2	8.7	79.5	86.2	112.3	93.9	101.1
45	MA908	AS	32.4	93.8	16.4	98.5	14.2	97.6	283.0	97.6	9167.9	91.6	12.0	110.1	78.0	101.6	92.3	99.4
46	MA910	AT	30.1	87.0	17.1	102.5	14.6	100.8	292.1	100.8	8726.8	87.2	11.0	100.9	76.1	99.1	91.5	98.6
47	MA909	AU	33.3	96.3	16.0	96.3	13.8	95.2	276.0	95.2	9165.9	91.6	12.0	110.1	62.5	81.4	92.2	99.2
48	SV RR863	AV	36.6	105.9	16.3	98.0	14.2	98.0	284.0	98.0	10351.1	103.5	8.5	78.0	76.0	98.9	93.1	100.3
49	BTS 9935	AW	33.6	97.1	17.4	104.4	15.3	105.2	305.1	105.3	10196.5	101.9	8.7	79.5	82.4	107.3	93.3	100.4
		GRAND MEAN	34.60		16.70		14.50		289.80		10004.50		10.90		76.80		92.90	
		CV	7.00		2.20		2.70		2.70		7.50		123.00		10.50		0.90	
		Error d.f.	203		185		186		186		186		230		204		186	
		LSD	2.58		0.36		0.36		8.52		803.34		15.18		9.05		0.88	
		Alpha level	0.05		0.05		0.05		0.05		0.05		0.05		0.05		0.05	
		Max. Mean	40.90		17.50		15.30		305.10		11668.00		38.20		86.20		94.10	
		Max. Plot	45.10		18.30		15.90		318.20		12821.50		151.00		97.20		95.10	
		Min. Mean	29.20		15.80		13.50		270.20		8391.10		5.20		62.50		91.50	
		Min. Plot	21.00		15.00		12.30		246.40		5873.50		3.00		30.60		87.40	
		No. of Reps	6		6		6		6		6		6		6		6	
		Rep-Msqr	50.70		2.20		2.30		939.10		6638834.60		505.30		395.40		0.90	
		Residual	5.20		0.10		0.10		56.70		503972.00		180.00		64.00		0.60	
		RE-RCBD	213.70		136.20		132.10		132.20		192.00		100.00		100.20		118.60	

2019 Murdock OVT Results - Identified

			Tons		Sugar		ES		EST		ESA		Nitrate		Emergence		Purity	
Entry No.	Entry Name	Label	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct	Mean	Pct
1	SV RR875	A	27.3	110.1	16.3	99	14.1	99.3	282.4	99.3	7708.5	109.2	5.8	64	75.7	94.5	92.7	100.5
2	BTS 9967	B	26.4	106.4	16.6	100.6	14.2	100.1	284.7	100.1	7524	106.6	4.2	45.8	78	97.4	91.9	99.7
3	BTS 9810	C	25.8	104	17.1	103.6	14.7	103.4	294.2	103.5	7549.5	106.9	5.5	60.3	81.1	101.2	92.1	99.8
4	BTS 9902	D	27.7	111.5	16.4	99.7	14.2	99.5	283	99.5	7819.3	110.7	8.4	93	84.6	105.5	92	99.8
5	BTS 9928	E	22.8	91.9	17.2	104.3	15.1	106.4	302.7	106.4	6915.3	97.9	21	231.8	84.2	105.1	93.5	101.4
6	BTS 9944	F	22.9	92.1	16.4	99.3	14.2	99.9	283.9	99.9	6498.7	92	13	143.1	79	98.6	92.6	100.5
7	Crystal M821	G	24.9	100.4	17	102.8	14.7	103.2	293.3	103.2	7303.9	103.4	29.3	323	79.4	99.1	92.5	100.3
8	SV 893	H	26.2	105.8	16.6	100.5	14.5	102.2	290.6	102.2	7757.9	109.9	7.9	87	80.1	100	93.1	101
9	HIL2219	I	20.2	81.5	16.9	102.5	14.8	104	295.6	104	5960.6	84.4	4.4	48.5	75.1	93.7	92.9	100.8
10	Crystal M978	J	22.9	92.3	16.9	102.2	14.5	102	289.9	102	6454.8	91.4	3.3	36.1	80.9	100.9	91.9	99.7
11	Baseline 9a SV RR863	K	27.8	112.2	16.4	99.5	14.1	99.4	282.5	99.4	7850.5	111.2	6.1	67.3	77.6	96.9	92.3	100
12	HIL9739	L	19.9	80	15.5	93.7	13.1	92.3	262.4	92.3	5209.2	73.8	5	55.4	81.1	101.3	91.5	99.2
13	Crystal M951	M	30.5	123	16.1	97.6	13.9	97.6	277.4	97.6	8562.9	121.3	12.7	139.6	84.2	105.1	92.5	100.3
14	SV 897	N	25.7	103.5	16.2	98.3	13.9	97.9	278.2	97.9	7387.3	104.6	8	87.8	77.4	96.6	92	99.7
15	Crystal M837	O	23.9	96.1	17.1	103.8	14.8	104.2	296.4	104.2	7079.8	100.3	5.6	61.1	77.2	96.3	92.3	100.1
16	SV 883	P	26.2	105.4	16.4	99.5	14.1	99.1	281.9	99.1	7390.5	104.7	4.8	52.9	81.8	102	92.2	100
17	HIL2326	Q	19.9	80.3	16.4	99.2	14.1	98.9	281.2	98.9	5558.7	78.7	15.8	173.7	89.2	111.4	92.1	99.8
18	Baseline 6a Crystal RR265	R	26.3	106.2	16.1	97.7	13.8	96.7	275	96.7	7233.6	102.4	12	132.1	78.1	97.4	91.7	99.4
19	SV 881	S	25.9	104.5	16.2	98.2	14.1	99.1	281.8	99.1	7293.1	103.3	3.7	40.8	79.4	99.1	92.9	100.8
20	Crystal M942	T	18.6	74.9	15.7	95	13.4	94.5	268.6	94.5	4833.3	68.5	9.6	105.5	73.9	92.2	91.9	99.7
21	HIL2329	U	22.4	90.2	16.6	100.4	14.2	100.2	284.9	100.2	6383.9	90.4	4.4	48	70.4	87.9	92	99.8
22	HIL2327	V	27.9	112.5	16.2	98	13.9	97.9	278.4	97.9	7789.4	110.3	9.8	107.5	78.2	97.6	92.5	100.3
23	Crystal M509	W	27.4	110.4	16	96.8	13.6	95.5	271.6	95.5	7446.3	105.5	10.4	114.8	83.8	104.6	91.7	99.4
24	HIL2328	X	22	88.8	16.8	101.6	14.4	101.2	287.9	101.3	6180.2	87.5	33.7	371.1	77.3	96.5	91.9	99.7
25	SV RR862	Y	27.2	109.6	16.6	100.3	14.3	100.5	285.6	100.5	7755.7	109.8	6.4	70.5	84.2	105.1	92.1	99.9
26	Crystal M998	Z	23.8	96.1	16.7	101.5	14.5	102	290	102	6909.4	97.9	4.7	52.1	80.1	100	92.6	100.4
27	Baseline 8a Hilleshog 9093RR	AA	23.3	94	15.6	94.9	13.5	95	270	95	6440.8	91.2	6.7	73.7	79.5	99.2	92.7	100.5
28	BTS 9780	AB	26	104.7	16.9	102.2	14.6	102.6	291.6	102.6	7449.3	105.5	18.3	201.2	85.8	107.1	92.3	100.1
29	SV 895	AC	24.1	97	16.7	101.4	14.5	102.3	290.9	102.3	7014.9	99.4	13.9	152.8	84.6	105.6	92.8	100.6
30	SV 894	AD	27.6	111.2	16.1	97.9	13.7	96.3	273.8	96.3	7498.7	106.2	4.1	44.7	80.4	100.4	91.4	99.1
31	BTS 9986	AE	27.9	112.6	16.3	99.1	14.2	100	284.3	100	7964.7	112.8	7.3	80.2	84.1	105	92.8	100.6
32	SV 892	AF	27.4	110.5	16.4	99.2	14.2	99.7	283.5	99.7	7774.8	110.1	3.9	43.3	76.9	96	92.5	100.3
33	SV RR876	AG	26.4	106.4	16.3	98.6	14.1	99	281.6	99	7560.9	107.1	12.7	139.5	82.4	102.8	92.7	100.5
34	SV 896	AH	27	109	15.8	95.9	13.7	96.1	273.2	96.1	7396.8	104.8	7	77.6	80.4	100.4	92.4	100.2
35	Baseline 7a Hilleshog 4017RR	AI	21.5	86.6	15.9	96.5	13.7	96	273	96	6084.3	86.2	12.7	140.3	74.4	92.8	91.8	99.6
36	Crystal RR018	AJ	22.3	90	16.4	99.7	13.8	97.1	276	97.1	6217.1	88.1	10.8	119	75.7	94.5	90.3	98
37	MA801	AK	21.2	85.5	16.4	99.4	14.2	99.9	284.1	99.9	6041	85.6	9.7	107.2	87.6	109.4	92.6	100.4
38	Crystal M623	AL	23.3	94.1	16.7	101	14.4	101.2	287.8	101.2	6718.5	95.2	5.8	64.3	78.1	97.4	92.2	100
39	BTS 9475	AM	24.3	98.1	17	102.9	14.8	103.7	295	103.7	7167	101.5	5.2	56.9	86.6	108.1	92.5	100.3
40	MA907	AN	21.2	85.5	16.1	97.4	13.6	95.5	271.5	95.5	5692.9	80.6	1.7	18.2	79.1	98.7	91	98.7
41	Crystal M977	AO	26.1	105.2	16.7	101.5	14.5	102.2	290.6	102.2	7578.4	107.3	13	143.1	77.7	97	92.8	100.6
42	Crystal M579	AP	27.6	111.3	17	103	14.5	101.8	289.4	101.8	7971.5	112.9	7	77	80.4	100.4	91.3	99
43	BTS 9952	AQ	22.1	89.2	16.6	100.5	14.4	101	287.3	101	6446.1	91.3	6.8	75.4	80.4	100.3	92.4	100.2
44	BTS 9916	AR	26.7	107.7	16.5	100.3	14.3	100.6	285.9	100.6	7544	106.8	4.4	48.3	82.5	103	92.4	100.2
45	MA908	AS	26.3	105.9	16.9	102.6	14.6	102.8	292.3	102.8	7830.3	110.9	5.2	57.1	85.7	107	92.1	99.9
46	MA910	AT	22.6	91.1	17	102.8	14.4	101.6	288.8	101.6	6531.7	92.5	5.5	60.9	81.9	102.2	91.1	98.8
47	MA909	AU	24	96.8	16.3	98.9	14	98.4	279.7	98.4	6768.3	95.9	8.6	95.1	65.5	81.7	91.9	99.7
48	SV RR863	AV	28.9	116.6	16.6	100.9	14.3	100.8	286.6	100.8	8290.3	117.4	13.4	147.3	81.1	101.3	92.1	99.9
49	BTS 9935	AW	25.1	101.2	17.7	107.6	15.5	109.3	310.7	109.3	7630.5	108.1	5.8	64.2	83.1	103.7	93	100.8
		GRAND MEAN	24.8		16.5		14.2		284.3		7060.6		9.1		80.1		92.2	
		CV	7.3		2.6		3.4		3.4		7.8		150.7		10.1		1	
		Error d.f.	202		169		205		205		168		169		204		205	
		LSD	2.1		0.5		0.5		10.8		621.0		15.3		9.1		1.1	
		Alpha level	0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1	
		Max. Mean	30.5		17.7		15.5		310.7		8562.9		33.7		89.2		93.5	
		Max. Plot	32.9		18.1		16.3		326.6		9150.5		142		102.8		95.6	
		Min. Mean	18.6		15.5		13.1		262.4		4833.3		1.7		65.5		90.3	
		Min. Plot	14.4		14.1		11.5		229.9		3916.6		1		0		86.5	
		No. of Reps	6		6		6		6		6		6		6		6	
		Rep-Msqr	18.1		2.5		2.6		1052.3		1074078		116.6		210.2		1.9	
		Residual	3.3		0.2		0.2		91.8		301189.4		182.2		64		0.9	
		RE-RCBD	100.1		104		100		100		100.5		101.1		100.1		100	

Date of Harvest Trials
Lake Lillian, Hector, and Murdock, MN - 2019

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 2019, the three Date of Harvest Trials were conducted at a location near Murdock, Lake Lillian and Hector. Trial maintenance was performed similar to the nearby Official Variety Trial, and followed Best Management Practices. Each week during the mid-August to early-October period approximately 180’ of row was harvested from each trial location. Harvest was accomplished with a tractor mounted one-row defoliator and one-row sugar beet harvester. The beets harvested each week were placed in tare bags and brought to the SMBSC Tare Lab for weights and quality analysis. Sample analysis included tare, sugar content, purity, and brie nitrate. 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 14, 2019. Harvesting continued on a weekly basis until October 25, 2019. Despite difficult harvest conditions due to the frequent rains and wet soils, we were able to harvest during each of the weeks in that period except for Week 5 and 8 where heavy rainfall prevented harvesting. A total of nine harvests were completed in 2019. Roughly half of harvest weeks during this time period were difficult due to frequent rain and wet soils. Root rot at all three locations was minimal and Cercospora leafspot was controlled well for the majority of the season.

Table 1 shows the average pounds extractable sugar per acre increase per day for each of the past nine years, between mid-August to early-October. From 2011-2018, the daily average rate of increase in ESA was 80.5 pounds extractable sugar per day. 2019 had a slightly lower rate of production at 78.6 pounds ESA per day. 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 2019, sugar increased at a rate under the long term average at 0.04% per day and approximately 0.3% per week. This is slightly reduced from the nine year average. That said, 2018 saw an unprecedentedly low rate of gain. When removed, the long term rate of gain is closer to 0.07% sugar per day. Figure 2 illustrates the data from 2019 for sugar percent rate of gain.

Table 3 shows the rate of gain for tons per acre for 2019. The 2019 rate of gain for TPA continues to show a relatively linear rate of gain at 0.24 TPA per day and 1.66 TPA per week. This is slightly higher than the long term average of 0.21TPA per day and 1.47 TPA per week. Figure 3 illustrates the data collected in 2019.

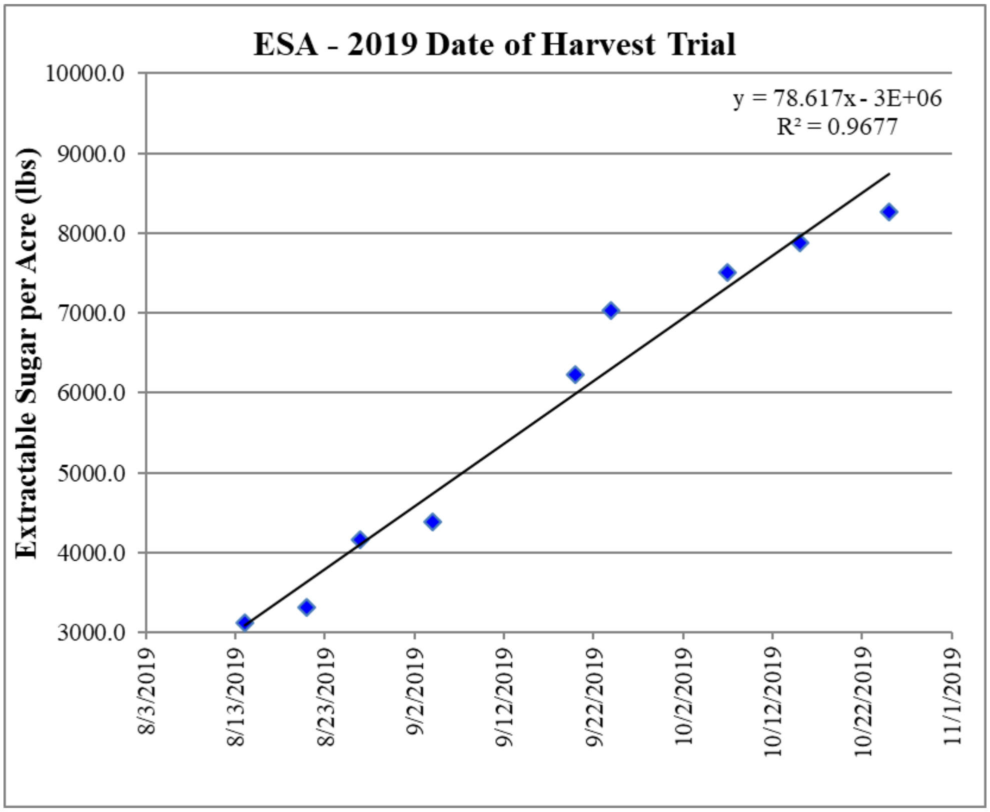

Figure 1. Extractable sugar per acre (ESA) data collected during the 2019 Date of Harvest trials, plotted across the harvest period, depicting a general positive trend.

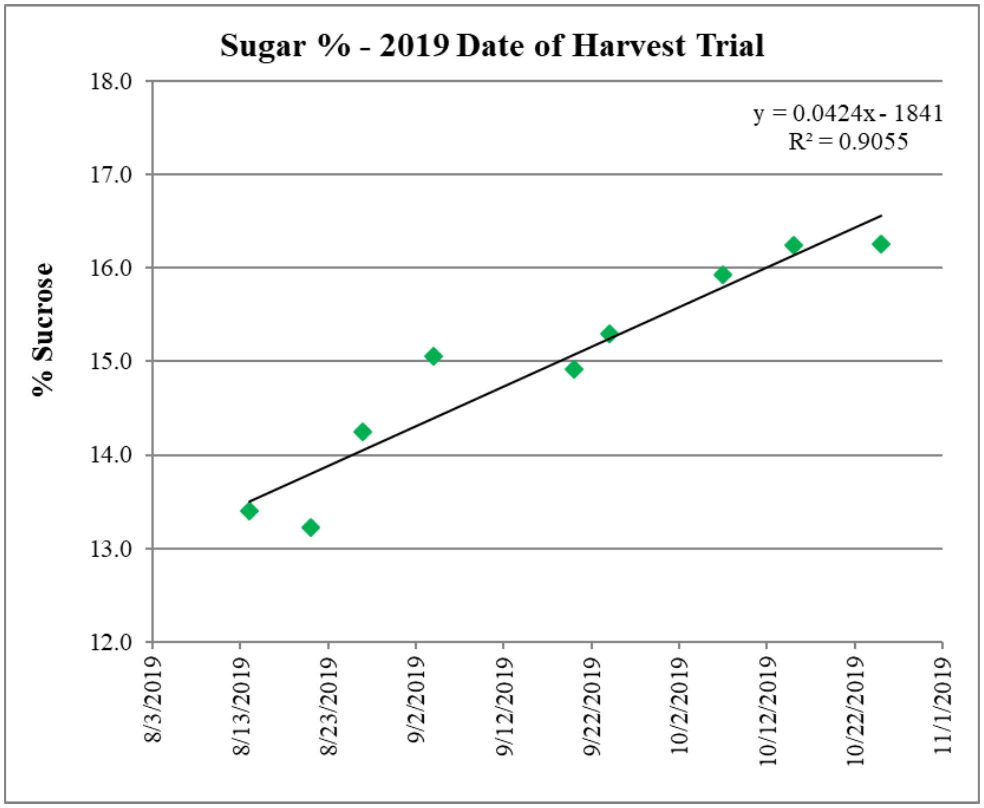

Figure 2. Sugar percent data collected during the 2019 Date of Harvest Trials, plotted across the harvest period, depicting a general positive trend.

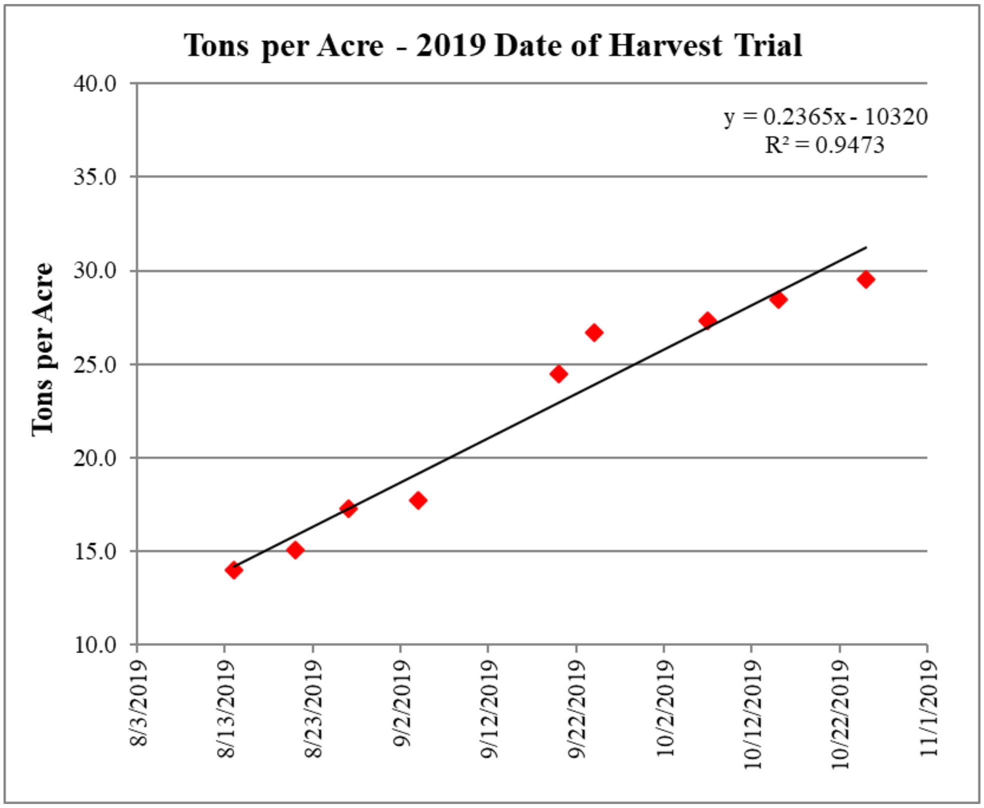

Figure 3. Tons per acre data collected during the 2019 Date of Harvest Trials, plotted across the harvest period, depicting a general positive trend.

Table 1.

2011-2019 Regression Analysis of Extractable Sugar per Acre Increase per Day

Year	Extractable Sugar per Acre Increase per Day (lbs.)
2011	100.73
2012	89.02
2013	91.62
2014	93.40
2015	99.77
2016	45.70
2017	60.04
2018	63.77
Average (2011-2018)	80.51
2019	78.62

Table 2.

2011-2019 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
Average (2011-2018)	0.06	0.42
2019	0.04	0.30

Table 3.

2011-2019 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
Average (2011-2018)	0.21	1.47
2019	0.24	1.66

Split Nitrogen Applications in Southern Minnesota 2019 – non-irrigated heavy textured soils.

John A. Lamb and David Mettler

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 the negative effects on sucrose concentration and purity. The objective of this study is 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 it will also determine if the site is responsive to N application and b. to determine if a split N application is superior to a pre-plant or an in-season application.

Methods and Materials:

To meet the objectives, a study was conducted during the 2019 growing season at two locations within the Southern Minnesota Beet Sugar Cooperative growing area. The initial soil test values are reported in Table 1. Ten treatments, Table 2 and Table 3, were established at each site. 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 randomize complete block design with four replications. The plots were six – 22 inch rows wide and 35 ft. long. The pre-plant N applications were broadcast treatments of urea. The urea was incorporated immediately after application. The in-season N applications were injected between the sugar beet plant rows as liquid urea ammonium nitrate solution. The Redwood Falls location was planted on May 16, 2019 to Crystal M623 and the in-season N application occurred on June 19, 2019. This site was harvested on September 19, 2019. The Murdock location was planted on May 31, 2019 to Crystal M623. The in-season application was applied on June 25, 2019. Harvest occurred on October 8, 2019. The previous crops were corn and soybean at Redwood Falls and Murdock, respectively.

Table 1. Soil test information for 2019 In-season N locations.

Soil test and depth	Redwood Falls	Murdock
Nitrate-N (lb/A) 0-48 inches	43	46
Olsen P (ppm) 0-6 inches	5	8
Soil test K (ppm) 0-6 inches	177	208
pH (unitless) 0-6 inches	7.7	7.9
Organic matter (%) 0-6 inches	4.1	5.7

Table 2. Treatments for N application study at Redwood Falls site, 2019.

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 feet.

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. Previous crop was corn.

Table 3. Treatments for N application study at Murdock site, 2019.

Treatment number	Total N applied (ST* + Fertilizer)	Preplant*	Split
	-------------------- lb N/acre --------------------		
1	46	0	0
2	66	ST+20	0
3	96	ST+50	0
4	126	ST+80	0
5	156	ST+110	0
6	186	ST+140	0
7	96	25	25
8	126	40	40
9	96	0	50
10	126	0	80

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

The treatments were based on the nitrate-N soil test taken to a depth of 4 feet. The soil test was 46 lb N/A in the 0-4 ft depth. Previous crop was soybean.

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. These sites were planted about 2 to 3 weeks apart because of the wet soils. The Redwood Falls site was planted earlier but had wet soils during much of the growing season. The Redwood Falls site while planted earlier yielded less tonnage and quality than the Murdock site.

Nitrogen fertilizer response:

Stand: Sugar beet stand was measured after emergence on the center two rows of each plots, Table 4 and 5. This measurement included 20 foot of row. At both locations, the stand was reduced by the increased application of fertilizer N (Urea), Figure 1. This was a concern because of the effect the stand could have on root yield and extractable sucrose per acre. An analysis on all of the measured parameters was conducted using stand as a covariable. In this analysis, stand did not significantly affect any of the measured parameters.

Of the measured parameters, nitrogen fertilizer application affected root yield, sucrose, extractable sucrose per ton, and extractable sucrose per acre at both locations, Table 4 and 5. Root purity was not affected by N application.

Root yield: Root yield was affected by N application at both sites in 2019, Figure 2. At the Redwood Falls site the root yield response was quadratic with the maximum root yield occurring at soil test nitrate-N to 4 feet plus fertilizer of 123 lb N/A, Figure 2. At the Murdock the response of root yield to N application was negative, with root yield being reduced by N application, Figure 2.

Sucrose concentration: Sucrose was affected by N application at both locations, Tables 4 and 5. The response at the Redwood Falls site was quadratic. The application of N up to soil test plus fertilizer of 99 lb N/A increased sucrose percentage, Figure 3. After reaching 99 lb N/A the sucrose concentration was reduced. At the Murdock site, the addition of fertilizer N reduced the sucrose concentration 1.4 %.

Extractable sucrose per ton: Extractable sucrose per ton was affected by N application similar to sucrose concentration, Table 4 and 5. The N response was quadratic at the Redwood Falls site with a maximum extractable sucrose at the 95 lb N/A, soil test plus fertilizer applied, Figure 4. The extractable sucrose per ton was decreased 28 lb /ton at the Murdock site with the addition of N fertilizer.

Extractable sucrose per acre: Similar to root yield, the application of N fertilizer affected the amount of extractable sucrose per acre at each site, Table 4 and 5. The Murdock site yielded a greater amount of extractable sucrose per acre compared to the Redwood Falls site. The extractable sucrose per acre at the Redwood Falls site was increased up to the soil test plus fertilizer amount of 121 lb N/A and then the amount of extractable sucrose decreased, Figure 5. At the Murdock site, extractable sucrose was reduced 1100 lb/A with the application of N.

Table 4. Sugar beet stand, root yield, sucrose, purity, extractable sucrose per ton, and extractable sucrose per acre for all treatments in 2019 at the Redwood Falls site, LSMEANS.

N rate (lb N/A)		Total N*	Stand	Root yield	Sucrose	Purity	Extractable sucrose	
Pre-plant	In-season	lb N/A	plants/20 ft. of row	ton/A	%	%	lb/ton	lb/A
0	0	43	41.3	19.3	15.2	91.0	257	4956
20	0	63	41.3	21.1	15.5	92.5	267	5612
50	0	93	39.8	22.3	15.8	93.6	277	6192
80	0	123	39.5	22.9	15.3	91.0	259	5929
110	0	153	34.3	22.8	15.1	90.3	252	5736
140	0	183	35.0	21.7	15.1	91.6	257	5575
25	25	93	38.8	20.7	15.2	90.8	255	5358
40	40	123	39.0	22.4	15.6	90.1	260	5800
0	50	93	42.3	19.9	15.6	92.6	270	5376
0	80	123	42.8	22.8	15.6	92.1	268	6109
Grand mean			39.4	21.6	15.4	91.6	262	5669
				Statistical Analysis				
Treatment			0.003	0.002	0.02	0.20	0.05	0.006
N linear			0.0002	0.003	0.09	0.42	0.16	0.07
N quadratic			0.41	0.003	0.02	0.35	0.05	0.0005
Check vs Split trts			0.57	0.001	0.07	0.50	0.16	0.0006
C.V. (%)			7.4	5.9	2.0	2.0	3.9	7.0

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

Table 5. Sugar beet stand, root yield, sucrose, purity, extractable sucrose per ton, and extractable sucrose per acre for all treatments in 2019 at the Murdock site, LSMEANS.

N rate (lb N/A)		Total N*	Stand	Root yield	Sucrose	Purity	Extractable sucrose	
Pre-plant	In-season	lb N/A	plants/20 ft of row	ton/A	%	%	lb/ton	lb/A
0	0	46	37.8	24.3	16.3	91.7	279	6689
20	0	66	40.3	24.7	16.8	92.4	290	7139
50	0	96	38.3	26.7	16.3	91.7	278	7461
80	0	126	29.0	22.8	15.4	91.4	261	6008
110	0	156	27.3	22.2	15.1	90.7	254	5655
140	0	186	29.3	23.6	15.5	91.3	264	6154
25	25	96	39.8	24.1	16.4	92.2	283	6814
40	40	126	34.3	25.2	16.3	91.9	279	7007
0	50	96	40.5	25.1	16.5	91.9	284	7298
0	80	126	39.5	25.4	15.8	91.8	270	6637
Grand mean			35.6	24.3	16.0	91.7	274	6654
				Statistical Analysis				
Treatment			0.001	0.16	0.0008	0.32	0.0008	0.005
N rate linear			0.0001	0.07	0.0002	0.09	0.0003	0.004
N rate quadratic			0.95	0.56	0.73	0.92	0.76	0.41
Check vs split trt			0.75	0.60	0.46	0.79	0.58	0.61
C.V. (%)			13.7	7.8	2.9	1.0	3.7	8.2

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

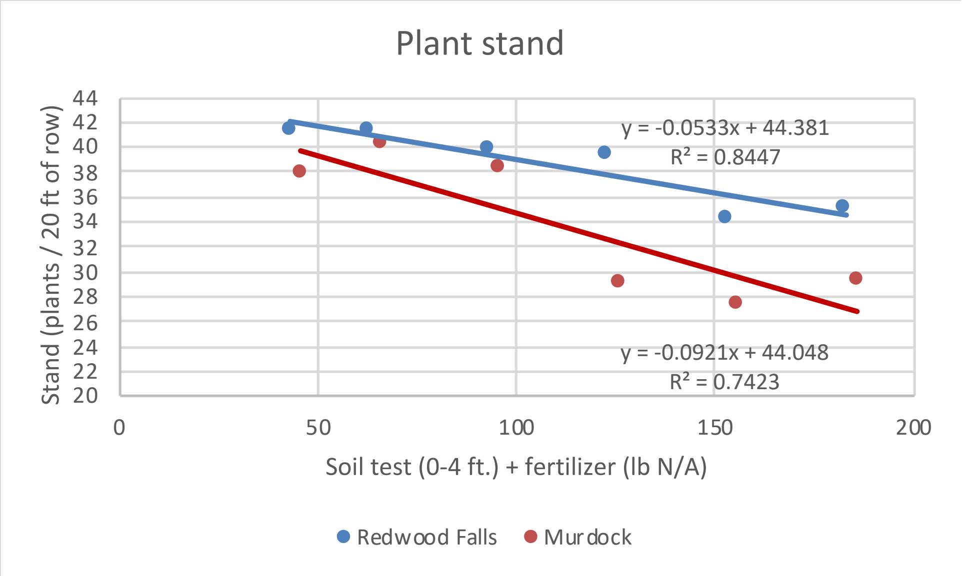

Figure 1. The effect of N fertilizer application on plant stand at Redwood Falls and Murdock sites, 2019.

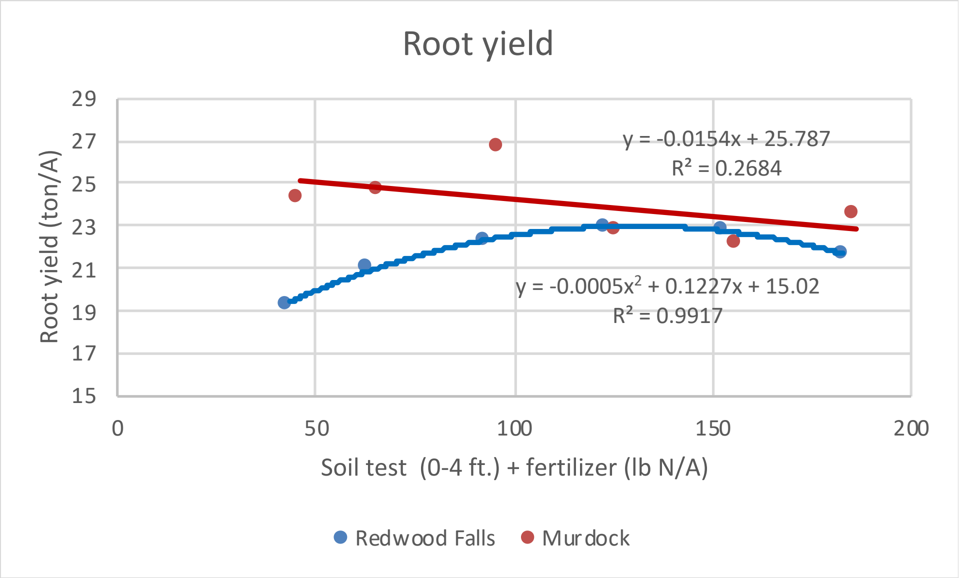

Figure 2. The effect of N fertilizer application on root yield at Redwood Falls and Murdock sites, 2019.

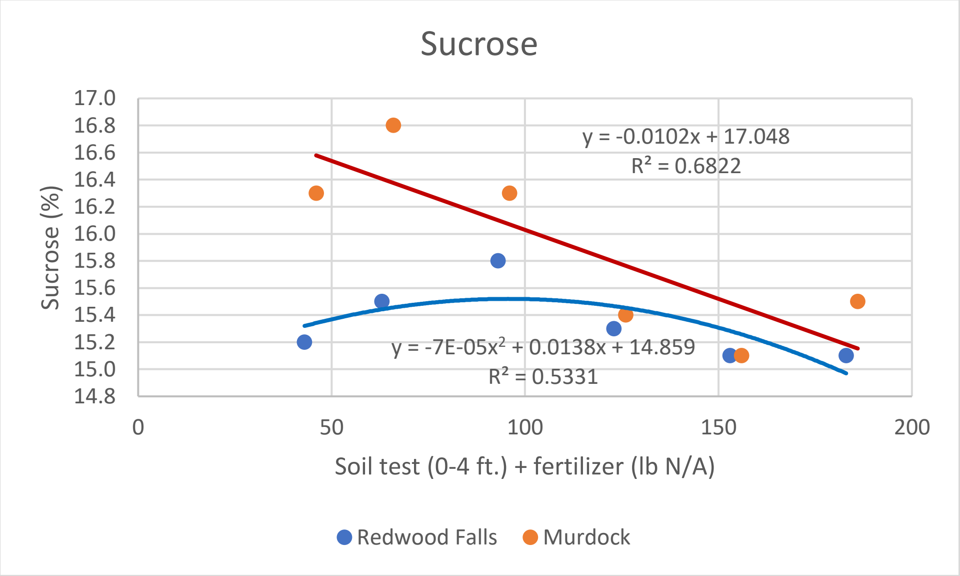

Figure 3. The effect of N fertilizer application on sucrose concentration at Redwood Falls and Murdock sites, 2019.

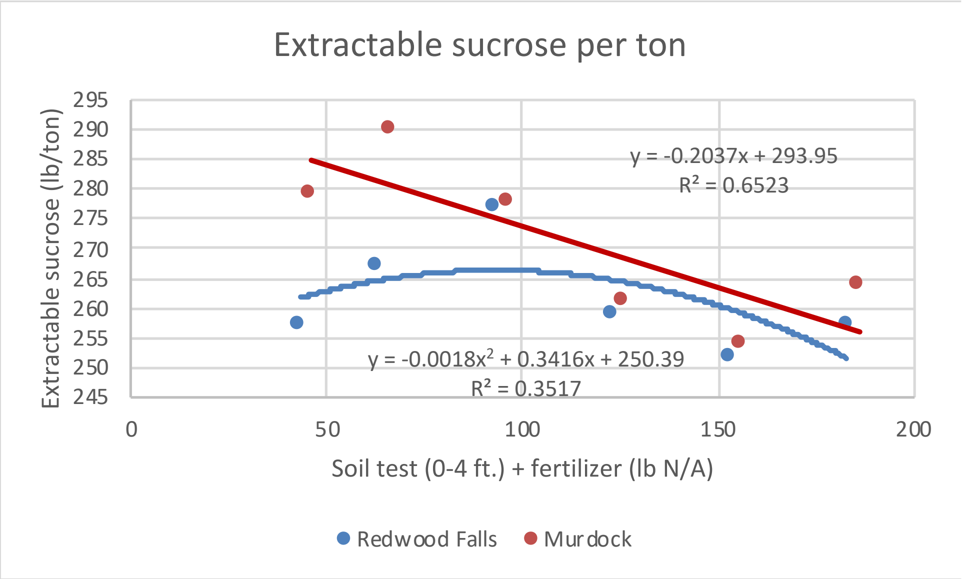

Figure 4. The effect of N fertilizer application on extractable sucrose per ton at Redwood Falls and Murdock sites, 2019.

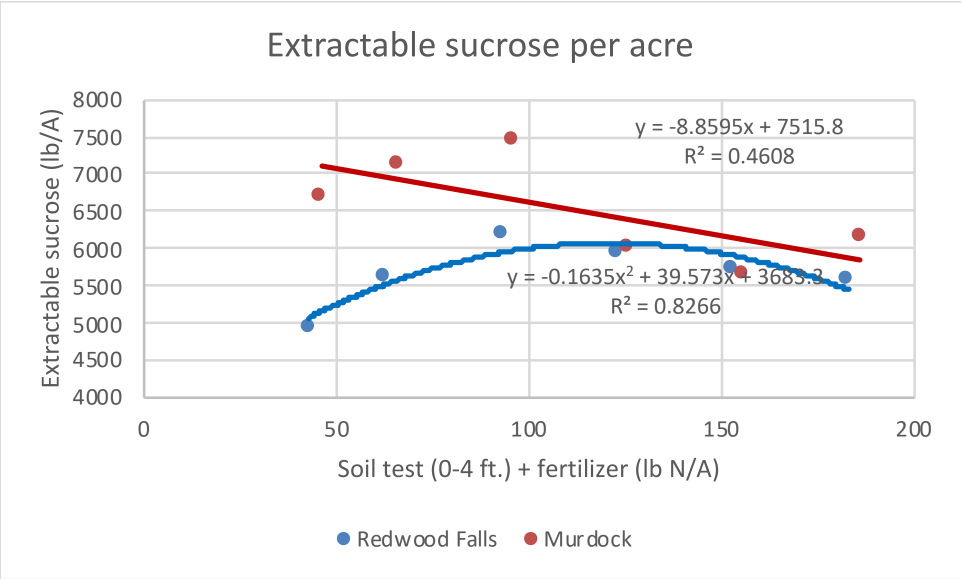

Figure 5. The effect of N fertilizer application on extractable sucrose per acre at Redwood Falls and Murdock sites, 2019.

Nitrogen fertilizer and timing:

Three different application methods and timing at two N fertilizer rates were applied in 2019. 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 only affected root yield, sucrose concentration, and extractable sucrose per acre at the Redwood Falls site in 2019. There were no significant differences for the parameters measured at the Murdock site. This was because the responses to N fertilizer were negative at the Murdock site.

At the Redwood Falls site, root yield was increased for the sugar beet treated with the different method and timing of N fertilizer compared to the root yield for the no N check treatment, Table 6. For root yield, only the increase in N rate from 50 to 80 lb N/A was responsive. The timing did not affect root yield. For sucrose concentration there was an interaction between N rate and the timing method, Figure 6.

Sucrose concentration was affected by the treatment in an interaction between N rate and Timing/Method, Table 6. Increasing N application rate from 50 to 80 lb N/A at pre-plant reduced sucrose concentration, Figure 7. All the N applied at either 50 or 80 lb/A at side-dress did not affect sucrose concentration while if the N was applied half at pre-plant and half at side-dress (split), the sucrose concentration was increased. The greatest sucrose concentration occurred with 50 lb N/A (96 lb N/A soil test plus fertilizer) applied at pre-plant.

Extractable sucrose was also affected by the N rate by Timing/Method interaction, Table 6. The interaction is presented in Figure 8. Nitrogen applied at pre-plant decreased extractable sucrose per acre when the N rate increased from 50 to 80 lb N/A. At the side-dress and split times of N application, the increase of N fertilizer from 50 to 80 lb N/A increased extractable sucrose per acre. The extractable sucrose per acre with all the N applied at 80 lb N/A at side-dress was similar to the extractable sucrose per acre for the pre-plant application at 50 lb N/A. There was no advantage to using a split application or side-dress N application compared to a pre-plant application. The pre-plant application resulted in a more efficient use of the N fertilizer.

Table 6. The effect of N application timing method on root yield, sucrose, and extractable sucrose per acre at Redwood Falls location 2019, LSMEANS.

N rate (lb N/A)		Total N*	Root yield	Sucrose	Extractable sucrose
Pre-plant	In-season	(lb N/A	ton/A	%	lb/A
0	0	43	19.3	15.2	4956
Rest			22.1	15.5	5820
50	0	93	22.3	15.8	6192
80	0	123	22.9	15.3	5929
25	25	93	20.7	15.2	5358
40	40	123	22.4	15.6	5800
0	50	93	19.9	15.6	5376
0	80	123	22.8	15.6	6109
			Statistical Analysis		
Check vs rest			0.001	0.07	0.0006
N rate			0.005	NS	0.1
Timing			0.20	NS	0.09
N rate * Method			0.21	0.05	0.06
C.V. (%)			5.9	2.0	7.0

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

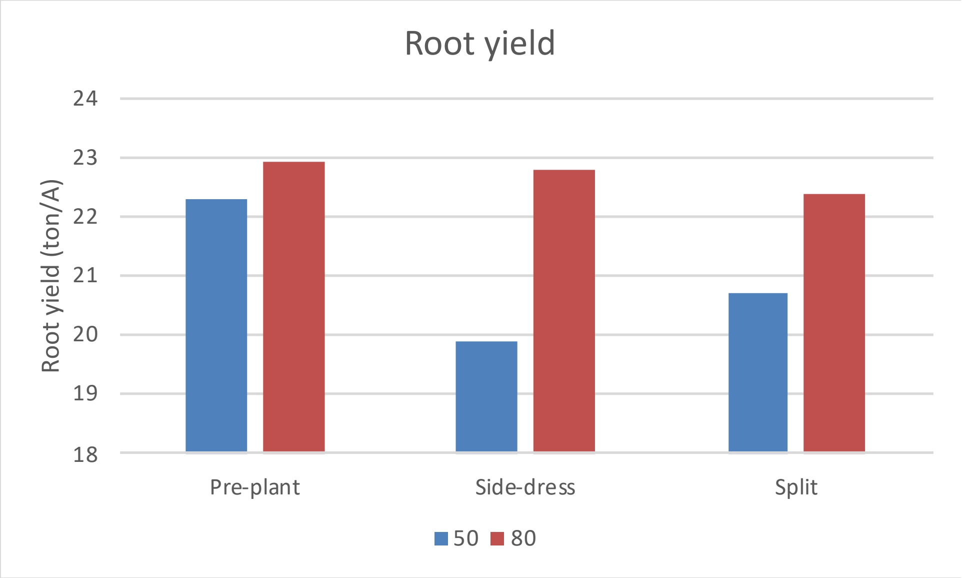

Figure 6. The effect of N application rate and timing/method on root yield at Redwood Falls site in 2019.

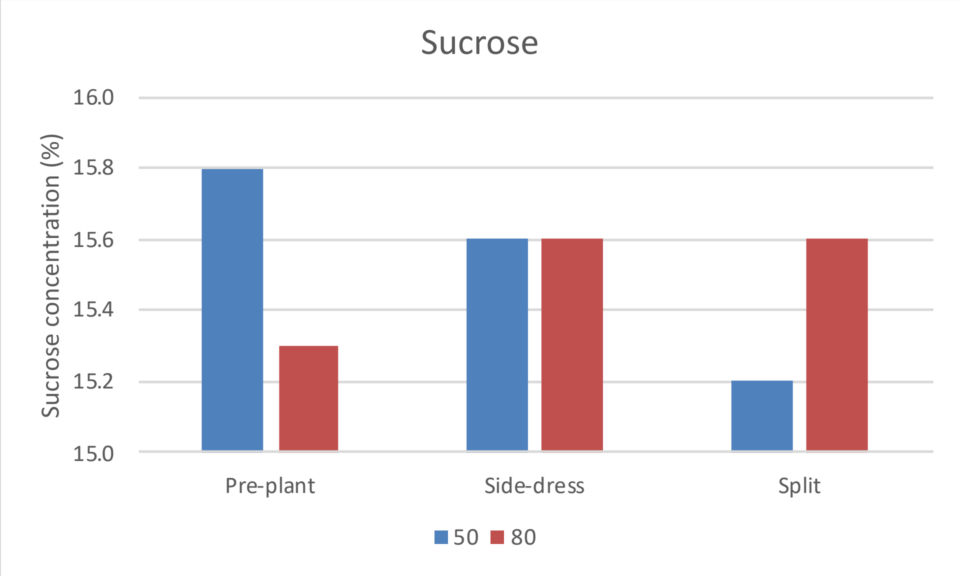

Figure 7. The effect of N application rate and timing/method on sucrose concentration at Redwood Falls site in 2019.

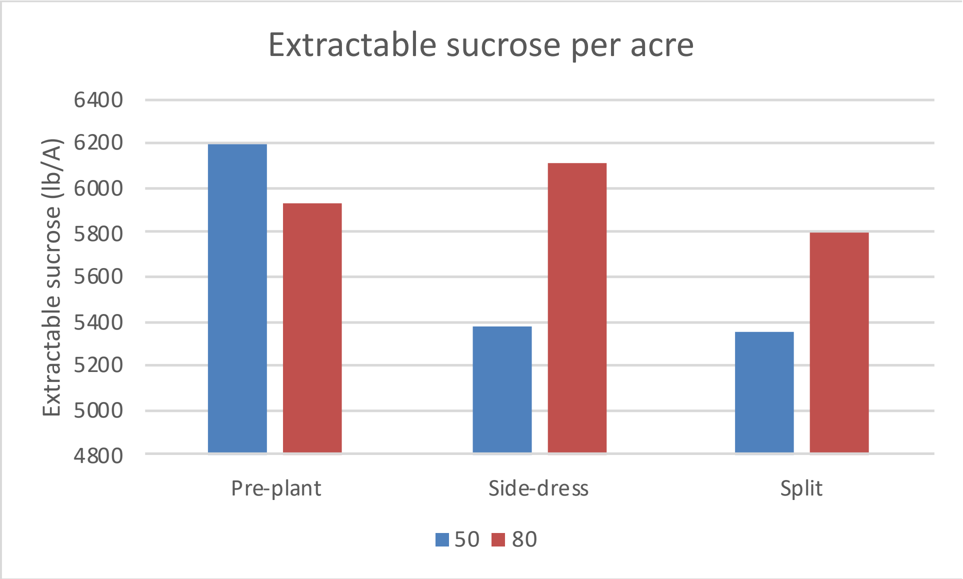

Figure 8. The effect of N application rate and timing/method on extractable sucrose per acre at Redwood Falls site in 2019.

Summary:

In 2019, weather conditions caused delayed planting and reduced production. The use of N fertilizer caused significant responses to root yield, sucrose concentration, extractable sucrose per ton, and extractable sucrose per acre. At the Redwood Falls site, the N response was quadratic with the optimum N application, soil test nitrate-N to 4 feet plus fertilizer was 123 and 121 lb N/A for root yield and extractable sucrose per acre. This site was planted in mid-May and was able to utilize some of the applied N. The Murdock location, planted at the end of May, responded negatively to N application for root yield, sucrose concentration, extractable sucrose per ton, and extractable sucrose per acre. The site had an initial soil test of 43 lb N/A in the surface 4 feet. The previous crop at Murdock was soybean. A N credit could also be possible. At that soil test level and if a soybean credit of 40 lb N/A acre was used, the response to N application could be small. Growing conditions were less than optimum because of the late planting date and the excessive moisture conditions during the growing season.

Use of different N application times/methods did affect root yield, sucrose concentration, and extractable sucrose per acre at the Redwood Falls site. In comparing pre-plant, side-dress, and split application method, the pre-plant time produced similar root yield to the other methods and was more efficient in using N fertilizer for extractable sucrose per acre.

Replanting Guidelines for Sugar Beet Production in the SMBSC Growing Area

Mark Bloomquist
Research Director

Introduction: Establishing an adequate plant population of sugar beets is one of the first challenges of sugar beet production. Every season a percentage of the acres planted in the SMBSC growing area emerge to a plant population that is less than the population that was planned for the field. There were working thresholds used to determine the plant population that warranted replanting sugar beets, however there was no data that existed in the literature or past research reports to support these thresholds. To develop a replanting threshold for SMBSC, a two-year research study was conducted. This report is an abbreviated version of the full paper published in the Journal of Sugar Beet Research. The full report can be found as follows:

Bloomquist, M. W., A. W. Lenssen, and K. J. Moore. 2019. Replanting guidelines for sugar beet production in southern Minnesota. J. Sugar Beet Res. 56:3-20. DOI: 10.5274/jsbr.56.1.3

Objective: To provide data to support plant population guidelines for the determination of the plant population at which a shareholder would be agronomically and economically better off to replant a field versus keeping a less than desired plant population from the original planting.

Materials and Methods: Three trials were conducted over the 2016 and 2017 growing seasons. In 2016, trials were located near Murdock and Lake Lillian. In 2017, a trial was located south of Renville. These trials were designed as a randomized complete block in a split plot arrangement with six replications. The main plot was the planting dates and the subplots were the six plant populations. Each individual plot was four 22" rows wide by 40' long. All three trials were planted in the first week of May and the replant treatment was planted 19-20 days following the original planting date. Beta 92RR30 was the variety planted at all three locations. The trials were planted at a 3.4" seed spacing to assure all plant populations were met. The trials were hand thinned at the 4-6 leaf stage to the appropriate plant populations. The six plant populations in the trial were as follows: 75, 100, 125, 150, 175, and 200 sugar beets per 100' of row. Normal agronomic practices were used to keep the trial weed and disease free. The center two rows of each four row plot were harvested in late September to mid- October. The harvest dates for the three locations varied depending on field conditions and trial harvest across the Cooperative. Trials were harvested using a four row defoliator and a two row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for quality analysis at the tare lab. Data from all three locations was combined for the analysis. The data was analyzed for significance using SAS version 9.4 utilizing the PROC MIXED and PROC REG procedures. Differences were considered significant at $P \leq 0.05$.

Results and Discussion: The results for the planting date analysis is shown in Table 1. These results show the effects of the delay in planting between the two planting dates. The data for each planting date is the mean of all plant populations for that planting date.

Plant Date	Tons/Acre	Sugar %	EST	ESA	$/Acre
1	29.4 a	15.8 a	268.1 a	7842 a	-- a
2	25.1 b	15.6 a	263.4 b	6607 b	-$180 b

Table 1: Effect of planting date on yield across all plant populations.

The results for the plant population treatment analysis is shown in Table 2. These results show the effects of plant population on yield. The data for each plant population is the effect of plant population across both planting dates.

Plant Population (Beets/100')	Tons/Acre	Sugar %	EST	ESA	$/Acre Difference
75	21.9 d	15.6 a	261.9 c	5703 e	-$342 e
100	24.7 c	15.7 a	264.4 bc	6520 d	-$226 d
125	27.9 b	15.7 a	265.1 bc	7364 c	-$113 c
150	28.8 b	15.8 a	267.3 ab	7672 b	-$61 b
175	29.8 a	15.9 a	270.2 a	8033 a	----- a
200	30.5 a	15.7 a	265.6 bc	8058 a	-$15 a

Table 2: Effect of plant population across both planting dates.

A regression analysis was utilized with the means of all plant populations for each of the two planting dates for extractable sugar per acre. The results of this analysis are shown in Figure 1. The blue diamonds represent the yield for each of the six plant population treatments in the first planting date. The red squares represent the yield for each of the six plant population treatments in the second planting date. The difference between the two lines is the extractable sugar yield difference that occurred between the two planting dates at each plant population. By looking at Figure 1, you can compare the extractable sugar per acre yield at each plant population for each planting date. The extractable sugar yield for Plant Date 1 of 100 sugar beets per 100' of row is approximately equal to the highest extractable sugar per acre yield of any of the plant populations for Plant Date 2. This data would indicate that if a producer has a sugar beet plant population of 100 sugar beets per 100' of row from an original planting, there is no potential to increase extractable sugar yield by replanting the field. For plant populations from an original planting that are below 100 sugar beets per 100' foot of row, the potential does exist to increase extractable sugar yield if the replanted population of sugar beets exceeds 125 sugar beets per 100' of row. This data indicates that the replanting threshold for sugar beets in the SMBSC growing area would be 100 sugar beets per 100' of row.

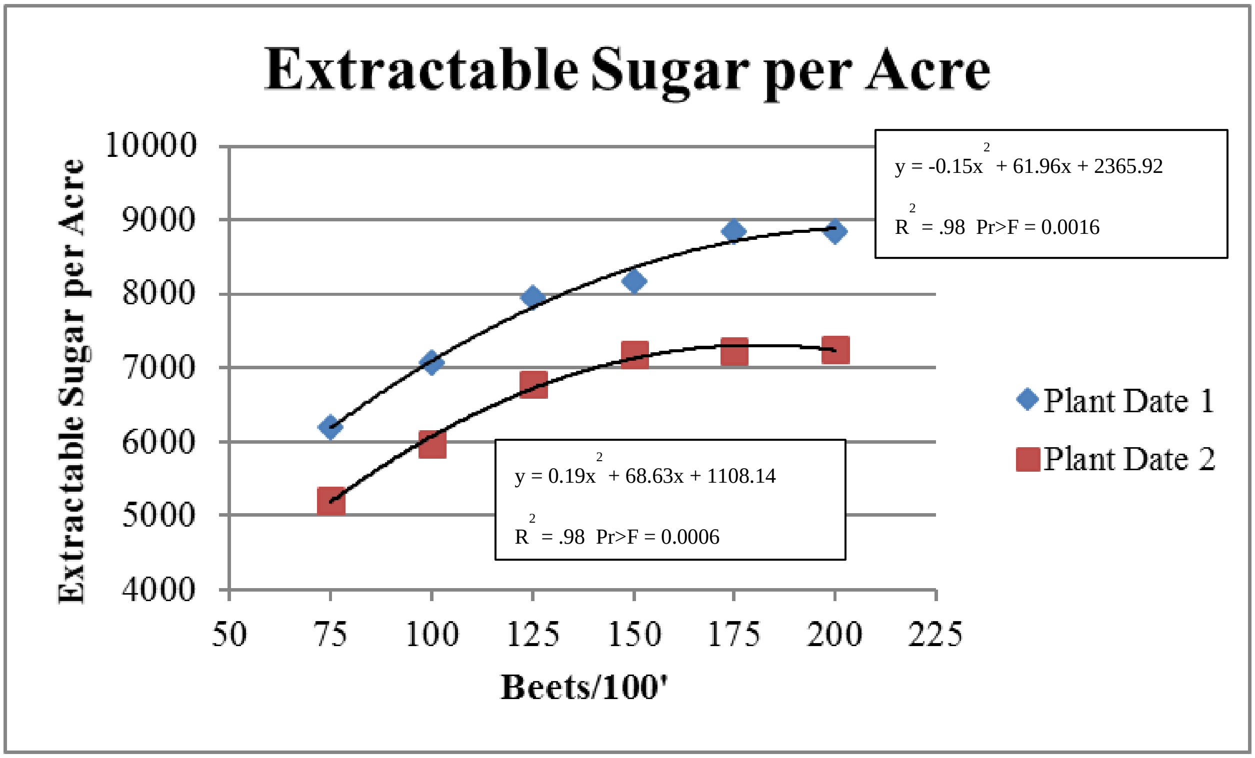

Table 1. Regression analyses of extractable sugar per acre yield by plant population for each of the two planting dates used in the study.

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 efficiency 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 are currently available for use in sugar beets that may have the ability to improve the sugar content of the crop.

Materials and Methods: A trial was conducted near the Murdock piling site to screen several products that may have the ability to improve sugar content. The trial was planted on June 3rd using Hillshog 9739 with three gpa of 6-24-6 starter fertilizer. 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 four 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. All of the treatments were applied on September 10th using a hand boom with XR8002 nozzles at 40psi with 17gpa. The center two rows of each six row plot were harvested on October 18th using a six row defoliator and a two row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the 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 better than the control. These are results from a one year study with a limited number of entries. Additional testing needs to be done to see if there is a product that could improve the sugar content of beets in the SMBSC growing area.

Treatment	Percent Sugar	Tons/Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity	Brei Nitrate (ppm)
Control	16.0	26.9	13.7	274.8	7384.3	92.3	4.0
Max-In Boron	15.8	26.2	13.6	271.5	7111.5	92.0	9.3
K-Express	16.0	26.7	13.7	274.3	7326.5	91.9	4.5
Trt 4	15.9	25.6	13.5	269.8	6911.8	91.6	8.8
Mean	15.9	26.4	13.6	272.6	7183.5	91.9	6.6
CV%	1.3	7.4	1.4	1.6	7.1	0.9	77.6
Pr>F	0.5122	0.7871	0.2380	0.3695	0.5657	0.6696	0.3803
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS

Table 1: Yield parameter results for the Sugar Enhancement Trial. Treatment 4 was a propriety product.

Mineralization Trial

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Introduction: The sugar content and purity of a beet crop is a major factor in how efficiently the factory can operate and ultimately how profitable the sugar beet crop will be to the shareholders. The SMBSC growing area has struggled to increase the sugar content of the beet crop in recent years with above average rainfall. The high organic matter of the soils in the SMBSC growing area can mineralize large amounts of nitrate during periods of warm, wet weather. 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: 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. Normal agronomic practices were used to keep the site weed and disease free. Four treatments were set up in a randomized complete block design with four replications (Table 1). The treatments were applied to the center three inter rows of six row plots and were tested for the ability to tie up nitrate. The rye treatment was seeded on July 19th by hand and then incorporated with a small row crop cultivator. Before the sawdust and sugar treatments were applied on August 15th a one foot soil sample was taken and following application soil samples were taken every two weeks until harvest. The sawdust and sugar were also incorporated using a small row crop cultivator. The center two rows of each six row plot were harvested on September 19th using a six row defoliator and a two row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the tare lab. The soil sample dates were each analyzed separately. The soil sample analysis and yield quality analysis were done using SAS GLM version 9.4.

Treatment	Per Acre	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 (Table 2). 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. No significant differences were found in the yield parameters (Table 3). However, numerical differences between the sugar treatment and the control may indicate an increase in percent sugar with the reduction in soil nitrate.

	First Sample		Second Sample		Third Sample	
Treatment	**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
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
LSD (0.05)	NS	NS	2.4	NS	2.8	NS
Pr>F	0.7420	0.2509	0.0001	0.4539	0.0010	0.9892

Table 2: Nitrate and ammonium in one foot soil samples in pounds per acre.

Treatment	**Percent Sugar**	**Tons/Acre**	**Percent Extractable Sugar**	**Extractable Sugar per Ton (lbs.)**	**Extractable Sugar per Acre (lbs.)**	**Percent Purity**	**Brei Nitrate (ppm)**
Control	15.8	22.3	13.6	271.5	6055.9	92.3	11.5
Sugar	16.4	22.1	13.9	277.7	6173.1	90.9	21.8
Sawdust	16.0	20.9	13.7	274.7	5728.5	92.0	16.3
Rye	15.9	21.2	13.7	274.9	5820.9	92.8	16.0
Mean	16.0	21.6	13.7	274.3	5912.0	92.2	16.4
CV%	1.5	7.2	3.1	3.1	4.3	1.9	66.0
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS
Pr>F	0.13	0.54	0.90	0.90	0.37	0.71	0.63

Table 3: Yield parameter results.

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 realistic or economical. With some data showing that it is possible to reduce late season mineralization additional research needs to be done to find an economical way of reducing nitrate mineralization and increasing percent sugar.

Cover Crop Interseeding Trial

David Mettler[1] and Mark Bloomquist[2]
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Introduction: The sugar content and purity of a beet crop is a major factor in how efficiency 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 solution that could substantially increase the sugar content of the beet crop would be a monumental achievement. Another issue facing sugar beets is the lack of residue and ground cover following harvest. The establishment of a cover crop after harvest has proven difficult with the late harvest of sugar beets. The interseeding of cover crops in sugar beets during the season could tie up excess nitrate in the soil and provide ground cover to prevent soil erosion after harvest.

Objective: To test the ability of cover crop species to establish between sugar beet rows and provide ground cover after harvest.

Materials and Methods: A trial was planted on June 3rd using Hilleshog 9739 near the Murdock piling site. 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 five treatments. Plots in this trial were six rows wide with the center 3 inter-rows being treated and the center two rows harvested. The cover crop treatments were seeded on July 19th applying the seeds by hand down the row and incorporated via interrow cultivation. Plots were harvested on October 18th using a six row defoliator and a two row research harvester. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the 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). With the late planting the cover crop seeding took place later in the season than planned and the cover crop species did not appear to establish well (Figure 1). Some of the cover crop species appeared to be sensitive to an application of Supertin plus Badge SC. The red clover had heavy leaf burn damage and was only in the cotyledon growth stage. The only cover crop species that appeared to survive the defoliation process was the ‘Kodiak’ mustard (Figure 2). To successfully establish a cover crop during the growing season an earlier cover crop seeding may be required. However, this would conflict with the present weed control strategy in sugar beets of multiple glyphosate plus a chloroacetamide post application. Any cover crop planting would need to take place after the last glyphosate application and may be inhibited by any residual chloroacetamide.

Treatment	Seeding Rate lbs/acre	Percent Sugar	Tons/Acre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Winter Rye	20	16.1	25.8	13.9	277.8	7148.2	92.3
Annual Rye	20	16.1	23.1	14.0	279.7	6457.7	92.8
Mustard	5	16.2	22.8	14.1	281.4	6416.7	92.8
Red Clover	15	15.9	24.6	13.7	274.0	6737.4	92.3
Control	n/a	16.1	25.1	13.9	277.5	6839.2	92.3
Mean		16.1	24.3	13.9	278.1	6689.4	92.5
CV%		2.3	11.9	2.5	2.5	12.5	0.7
Pr>F		0.8247	0.5471	0.6319	0.6319	0.8439	0.6830

Table 1: Yield parameter results for the Cover Crop Interseeding Trial

Figure 1: Cover crop species have established by Aug 21st but are not developing high amounts of biomass. Cover crop plants are small and not vigorous.

Figure 2: Mustard plants survived the defoliation process in several plots. No other cover crop species were visible after defoliation.

VARIATION IN PLANT TISSUE CONCENTRATION AMONG SUGARBEET VARIETIES

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Justification: Plant tissue analysis has increasingly been used for crops as a tool to fine tune nutrient management. Plant analysis was developed as a diagnostic tool and has generally not been used to determine nutrients to apply. For sulfur, analysis of sulfur in plant tissue is commonly determined using inductively coupled plasma emission spectroscopy (ICP) even though older data that is typically used to develop sufficiency ranges may have been determined by dry combustion. Recent work in Minnesota on corn and soybean has found differences in the assessment of sulfur concentration by ICP versus combustion. Comparison of methods of analysis for sulfur for additional crops such as sugarbeet would help to determine the accuracy of ICP and where additional research in correlation of plant tissue tests to crop yield should be conducted. If differences in the methods can be documented, it would indicate that sugarbeet growers should exercise extreme caution when interpreting plant tissue results for sulfur.

Plant tissue analysis has resulted in more recent questions on boron application than other micro-nutrients. Reports that list boron as being low typically suggest a foliar application of boron containing fertilizer sources. However, there is no documented evidence that tissue sufficiency ranges currently used are accurate and that when a low tissue boron concentration is reported that application will increase crop yield. Comparisons of yield response to tissue concentration are needed to provide evidence that a sufficiency range actually has meaning when deciding if fertilizer should be applied.

Recent surveys of corn, soybean, and hard red spring wheat plant tissue has shown significant variation in nutrient concentration when multiple hybrids/varieties are sampled in the same field at the same time. If taken at face value, tissue nutrient concentration should be reflective of soil nutrient status. Past research on corn, soybean, and wheat showed a significant portion of the variation in nutrient concentration was due to growth stage differences among hybrids/varieties at sampling. What needs to be addressed for sugarbeet is the degree of variation in tissue nutrient concentration in petioles and leaf blades for varieties grown at multiple locations and years and whether plant tissue analysis can be related to root or sugar yield. If there is significant variation in concentration that is reflective of genetics and not of yield potential, there should be a significant degree of caution when interpreting tissue results without further documentation of deficiencies with additional analysis such as soil tests.

Objectives:

1. Compare nutrient concentration in petioles and leaf blades among varieties at three sampling times.
2. Determine if tissue nutrient concentration is predictive of root and sugar yield when sampling adequately fertilized fields.

Materials and Methods: Six sugarbeet varieties (listed below) were planted at four locations [three locations were sampled in 2019 (Table 1)] and tissue analysis samples were collected at three sampling times over the growing season. Varieties were planted in four replications at each site. Sampling times were early to mid-June, early July, and late July to early August. The newest developed leaf was sampled. The petiole and leaf blade were sampled as one then separated for individual analysis. All samples were dried, ground, and analyzed for nitrate N and Cl via extraction with 5% acetic acid, total N by combustion, and P, K, Ca, Mg, S, B, Cu, Fe, Mn, and Zn by ICP. A single composite soil sample consisting of six to eight cores was taken from the 0-6 and 6-24 inch depths from each site at each plant sampling date. Soil samples were analyzed using recommended procedures of N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, Zn, and Cl and for pH (1:1 soil:water), soil organic matter (loss on ignition), and cation exchange capacity [CEC (ammonium saturation and displacement)]. Plant tissue nutrient concentration was correlated with yield and quality to determine what factors may be important for the prediction of root and sugar yield. All data was subject to an analysis of variance procedure assuming fixed effects of location, sampling time, and variety and random blocking effects.

Varieties used in the sampling trial:

1. Crystal RR018 – Check variety: Good disease tolerance, average yield but below average sugar.
2. Maribo 109 – Check variety: Good disease tolerance with average sugar content. Below average tons. Tends to have a smaller leaf canopy than other varieties.
3. Beta 92RR30 –Average tons and average sugar.
4. Beta 9475 –Good Cercospora leaf spot resistance, high yield and average sugar.
5. Crystal M579 –High sugar content.
6. Crystal M509 – Good cercospora resistance, low sugar content and high yield.

Results: Sample timings were targeted to occur within three week intervals near the 50-80 day suggested for sugarbeet sampling. Actual sampling dates averaged 45, 65, and 88 days after planting which was ideal for the trial to study early, suggested, and late sampling timings. Soil types, chemical properties, and cation exchange capacity was relatively similar among soils at the eight locations.

Root yield, sugar content per ton, and sugar content produced per acre varied among the six varieties across locations and years (Table 3). Overall, root yield, sugar content, and sugar production followed anticipated patterns based on past varietal response data, but variety rankings did vary slightly by year (not shown). Some variation in varietal ranking may be due to differences in yield potential as a result of cercospora which had a greater incidence across locations in 2018 (not shown).

Differences in leaf blade nutrient concentration among varieties, when averaged across time and location, are summarized in Table 3. While significant, the relative differences in plant nutrient concentrations among the varieties were relatively small. The ranking among varieties (maximum to minimum concentrations) were not consistent indicating that varieties with greater nutrient concentration of a single nutrient were not greater for all nutrients. This indicates that plant nutrient uptake is not relatively greater for one variety versus another for all nutrients. Table 6 also lists the anticipated sufficiency range according to the Plant Analysis Handbook III for sugarbeet leaf blade tissue collected 50-80 days after planting. The average for boron tissue concentration was the only instance where a concentration average was close to the low end of the sufficiency range. However, the boron concentration in the leaf blade tissue did not necessarily indicate that boron was limiting yield. Results for leaf blade nitrate nitrogen and chloride are listed in Table 3, but there is no given sufficiency range for these nutrients.

Effects on all nutrient concentrations were similar for petioles (Table 4) as with leaf blades. However, the concentration of nutrients tended to be less in the petiole than in the leaf blade tissue. The major exceptions were potassium and chloride where the concentration was greater in the petiole than in the leaf blade. There is no identified sufficiency range for petiole tissue to compare results with established ranges.

The effect of time on macro and micronutrient concentrations is summarized in Figures 1 and 2, respectively. Most nutrients decreased in concentration in both the leaf blade and petiole samples over time starting at time one through time three. There were exceptions where some nutrients did not change over time or showed a temporary decrease from T1 to T2 but then increased from T2 to T3. Iron did exhibit a decrease over time, but this decrease was likely due to less soil contamination on leaves later in the growing season. As more leaves developed it was less likely that rain drops would reach the soil surface resulting in splashing of soil particles onto plant tissue. Due to contamination, tissue iron concentration should not be used as a predictor of yield and quality parameters. There was a large increase in copper from T2 to T3. The concentration of copper spiked in the leaf tissue at sampling time three as a result of copper being applied to treat cercospora. Tissue sulfur concentration generally increased in the leaf blade while it decreased in the petiole.

Plant tissue concentrations were correlated with root yield and sucrose content, but the data are not shown. Similar to root yield, there were no instances where sugar content or yield showed a consistent correlation with multiple nutrients. It would be expected that if a nutrient is limiting or if yield or quality is a function of nutrient concentration then there should be consistent correlation over time between these factors and the concentration of nutrients in the plant tissue. Nutrient concentration in plant tissue does not necessarily account for variations in plant growth and differences in nutrient remobilization among varieties. The data overall indicates that some caution should be exercised when interpreting plant tissue results as a correlation between yield and quality and a concentration of a specific nutrient at a single point during the growing season does not prove that uptake of any nutrient is driving final yield or sugar production.

The correlations between yield and quality parameters did change as data were collected over years (not shown). The change in the best correlations between yield or quality parameters and plant tissue concentrations over time indicate that some caution should be exercised when using correlation data. Also, correlation does not prove that one factor drives the other factor rather it shows there is a relationship. In order to be certain that a tissue concentration impacts yield or quality separate research needs to be conducted using cause and effect to determine how application of nutrients change tissue nutrient concentrations and whether yield or quality factors are impacted.

Average nutrient concentrations by location were regressed with multiple soil and environmental factors to determine if variation in tissue concentrations could be explained by variations in factors which cannot be controlled. Multiple environmental factors were studied including average minimum and maximum temperature, total precipitation, and growing degree day. All the previous factors were summarized based on the time from planting to sampling, 1 day, 3 days, 1 week, 2 weeks, and 3 weeks prior to sampling. Significant factors were grouped into long term (greater than 2 weeks) or short term (2 weeks or less) factors for summary in Figures 3 and 4. All soil factors in Tables 2a and 2b were utilized and were grouped into soil test or other soil (soil) factors after the analysis. Time factor considers the time (days) between planting and sampling. The remaining variation which could not be explained by the model was marked as unknown. Two micronutrients, iron and copper, were not regressed with soil factors as contamination of iron and copper through soil adhering to the plant tissue or foliar application of the nutrient due to greater than expected concentrations of either nutrient not as a result of plant uptake.

Figure 3 summarizes the relationship between blade total N concentration and root yield, and blade total Ca concentration and recoverable sugar. Best fit models show a general relationship between the factors. However, in this case both graphs, clustering of values within sites result in the positive relationships and it is questioned how accurate a model developed to predict yield or quality can do so. The graphs presented use actual yield and recoverable sugar values and prediction models typically use values relative to a maximum value in order to reduce the impact of random factors not accounted for in the model from influencing the relationship between yield or quality factors and tissue concentrations. For example, crop yield is an interaction between the varieties genetic potential and optimal growth factors at an individual site. Soil nutrient availability is one factor impacting yield but not the sole factor thus adjusting yield data. For this report yield data was not adjusted on a relative basis as it is unclear how to make adjustments when differences in yield are based on genetic factors only. With nutrient availability trials the maximum yield produced by increasing rates of nutrient applied are used to compare the yield produced by treatments to generate a relative yield as it relates to maximum yield potential by site for a specific cultivar.

The equations (a) through (f) below represent results from multiple regression analysis to determine if multiple factors combined can help predict root yield and recoverable sugar per ton. Equations a, b, and c identify significant prediction for root yield using plant tissue factors for sample times 1, 2, and 3, respectively. Equations e, f, and g identify prediction factors for recoverable sugar per ton for times 1, 2, and 3, respectively.

(a) root yield = -31.8 + 5.04(Blade N) + 1.28 (Blade B) – 0.000136 (Pet Cl)

(b) root yield = 57.0 – 27.7(Blade Mg) – 17.9 (Pet Ca) – 0.88 (Pet Cu)

(c) root yield = -20.7 + 0.82(Blade Zn) – 11.4 (Pet K) + 2.65 (Pet B)

(d) rec. sugar per ton = 80.6 -0.005(Blade NO3) + 20.9 (Blade P) -126.6 (Blade S) + 2.37 (Blade Zn) + 0.008 (Blade Cl) + 756.86 (Pet S)

(e) rec. sugar per ton = 446.6 – 213.9 (Blade Mg) – 332.7 (Blade S) + 1.09(Pet Mn)

(f) rec. sugar per ton = 351.7 – 183.3(Blade P) – 63.5(Blade Mg) – 0.17 (Blade Cu) + 1.41 (Blade Zn) – 80.4 (Pet Ca)

Time 1 prediction models could be used to predict 99% of the variability in yield and in recoverable sugar per ton with a combination of multiple factors. Combined r^2 values were poorer at time 2 compared to time 1 and for root yield at time 3 compared to time 1, but not for recoverable sugar at time 3 which had a total r^2 similar to time 1. This indicates that prediction is generally better for time 1 than the later sampling dates. What should be noted though is that all factors in the model do not necessarily have a positive impact on root yield or recoverable sugar. For example in equation a, root yield increased with increasing blade N and B concentration and decreasing petiole Cl content. One item to note is that there is some correlation between the different blade and petiole nutrient concentration as uptake of a single nutrient can impact the uptake of other nutrients. Also, prediction models are always better at backwards predicting values and seldom are good at forward predicting what may happen in future years. For example, many models exist to predict iron deficiency chlorosis in soybean but many fail to predict the severity and where IDC will occur when used in studies where the models did not generate data. Care should always be exercised when using multiple regression models as the data may be specific to the sites where the studies were conducted or cultivars used for the studies.

Conclusions: The data showed that there were clear differences in yield and quality among the sugarbeet varieties used in the study. Tissue (leaf blade and petiole) nutrient concentration will vary among sugarbeet varieties sampled in the same field at the same time. The concentration of most nutrients will decrease when sampling the same leaf relative to the top part of the canopy over time. The decrease or increase will occur for each nutrient similar for the leaf blade and petiole sample. Due to this variation, a large range in the recommended sampling time for leaf blade samples (50-80 days after planting) should not be used. The data indicates that earlier sampling around 40-50 days after planting may be more predictive of yield response compared to later samples. However, there was not strong evidence that root yield or recoverable sugar could be fully predicted by plant tissue concentration and that concentration of nutrients in leaf blade and petiole tissues could be explained by factors other than the soil test of a nutrient indicating much of the variation in plant tissue concentration is controlled by uncontrollable factors. The data indicates that significant caution should be exercised when collecting a single sample from a well fertilized field as there is no evidence that the concentration of a nutrient in the leaf or petiole has a direct impact on yield or quality.

Table 1. Location, planting and sampling information, dominant soil series, and cation exchange capacity (CEC) for each location (CC, Clara City; H, Hector; LL, Lake Lillian; M, Murdock; R, Renville).

	Date of				Soil		CEC		Particle Size		
Location	Planting	Sample 1	Sample 2	Sample 3	Series	Classification‡	0-6”	6-24”	Sand	Silt	Clay
							meq/100g			%	
					2017						
CC	25-May	12-Jul	2-Aug	22-Aug	Colvin-Quam	T Calciaquoll	31.6	25.5	18	53	30
LL	8-May	21-Jun	12-Jul	2-Aug	Nicollet	A Hapludoll	33.7	28.7	25	40	35
M	29-Apr	21-Jun	12-Jul	2-Aug	Bearden-Quam	Ae Calciaquoll	28.0	22.2	14	48	38
R	6-May	21-Jun	11-Jul	1-Aug	Chetomba	T Endoaquoll	31.1	24.4	22	43	36
					2018						
CC	17-May	27-Jun	18-Jul	14-Aug	Bearden-Quam	Ae Calciaquoll	30.9	20.9	16	48	37
H	10-May	21-Jun	9-Jul	2-Aug	Crippin	A.P. Hapludoll	35.8	28.5	10	49	41
LL	7-May	21-Jun	9-Jul	2-Aug	Nicollet	A Hapludoll	31.3	23.7	30	37	33
M	18-May	27-Jun	16-Jul	14-Aug	Bearden-Quam	Ae Calciaquoll	35.2	28.2	11	48	41
					2019						
H	7-May	17-Jun	11-Jul	31-Jul	Crippin	A.P. Hapludoll	40.5	34.9	18	42	40
LL	6-May	17-Jun	11-Jul	31-Jul	Okaboji-Canisteo	C.V. Endoaquoll	36.0	30.9	13	50	37
M	31-May	15-Jul	31-Jul	19-Aug	Byrne-Buse	C. Hapludoll	27.7	23.9	21	50	29

‡A, aquic; Ae, aeric; A.P., aquic pachic; C, calcic; C.V., cuuulic vertic; T, typic.

Table 2. Summary of analysis of variance for the main effect of sugarbeet variety by and across 2017-2019 locations. Numbers within rows which are followed by the same letter are not significantly different at $P \leq 0.10$.

Variety						
Crystal RR018	Maribo 109	Beta 92RR30	Beta 9475	Crystal M579	Crystal M509	*P*>F
Root Yield (tons/acre)						
28.3c	26.2d	26.7d	30.5b	29.5b	33.0a	
Recoverable Sugar (lbs/ton)						
265c	269bc	272b	267c	276a	259d	
Recoverable Sugar (lbs/acre)						
7633c	7143d	7313d	8209b	8223b	8623a	

Table 3. Varietal differences in leaf blade nutrient concentration across eleven locations from 2017-2019 and three sampling times at each location. Within rows, numbers followed by the same letter are not significantly different at $P \leq 0.10$.

	Variety						
Nutrient	Crystal RR018	Maribo 109	Beta 92RR30	Beta 9475	Crystal M579	Crystal M509	Suffic.†
	%						
Total-N	5.25a	4.87b	4.84b	4.88b	4.79b	4.87b	4.3-5.0
Phosphorus	0.53a	0.55a	0.46c	0.48bc	0.45c	0.51ab	0.45-1.1
Potassium	3.95a	3.74b	3.63d	3.62d	3.71bc	3.65cd	2.0-6.0
Calcium	0.68b	0.74a	0.73a	0.65c	0.67bc	0.69b	0.5-1.5
Magnesium	0.48d	0.52b	0.56a	0.50c	0.50c	0.52b	0.25-1
Sulfur	0.38	0.36	0.35	0.37	0.36	0.38	0.21-0.5
	ppm						
Nitrate-N	752a	400e	609bc	634b	478d	580c	
Boron	30	31	32	29	30	29	31-200
Copper	35c	40a	36bc	33c	39ab	33c	11-40
Iron	494a	389c	502a	439b	516a	516a	60-140
Manganese	65cd	68b	76a	63d	79a	67bc	26-360
Zinc	46ab	39c	44ab	44b	44ab	47a	10-80
Chloride	3059b	3516a	3076b	3117b	2996bc	2895c	

†Suffic, sufficiency range identified by Bryson et al., 2014.

Table 4. Varietal differences in petiole nutrient concentration across eleven locations from 2017-2019 and three sampling times at each location. Within rows, numbers followed by the same letter are not significantly different at $P \leq 0.10$.

	Variety					
Nutrient	Crystal RR018	Maribo 109	Beta 92RR30	Beta 9475	Crystal M579	Crystal M509
	-----%-----					
Total-N	2.54bc	2.60ab	2.65a	2.52cd	2.46d	2.61ab
Phosphorus	0.35bc	0.43a	0.35bc	0.35bc	0.33c	0.37b
Potassium	4.56	4.58	4.28	4.40	4.29	4.76
Calcium	0.44c	0.56a	0.49b	0.45c	0.49b	0.57a
Magnesium	0.26b	0.28a	0.28a	0.24d	0.24c	0.24c
Sulfur	0.14	0.15	0.13	0.14	0.14	0.14
	-----ppm-----					
Nitrate-N	4311c		5315a	4281c	3997c	4777b
Boron	23c	25s	24b	24b	23c	26a
Copper	9.6	9.5	8.6	9.9	9.0	9.5
Iron	307	300	267	257	289	285
Manganese	28b	29b	28b	26b	34a	30b
Zinc	20	21	18	18	19	20
Chloride	4980b		5880a	5742a	5665a	6103a

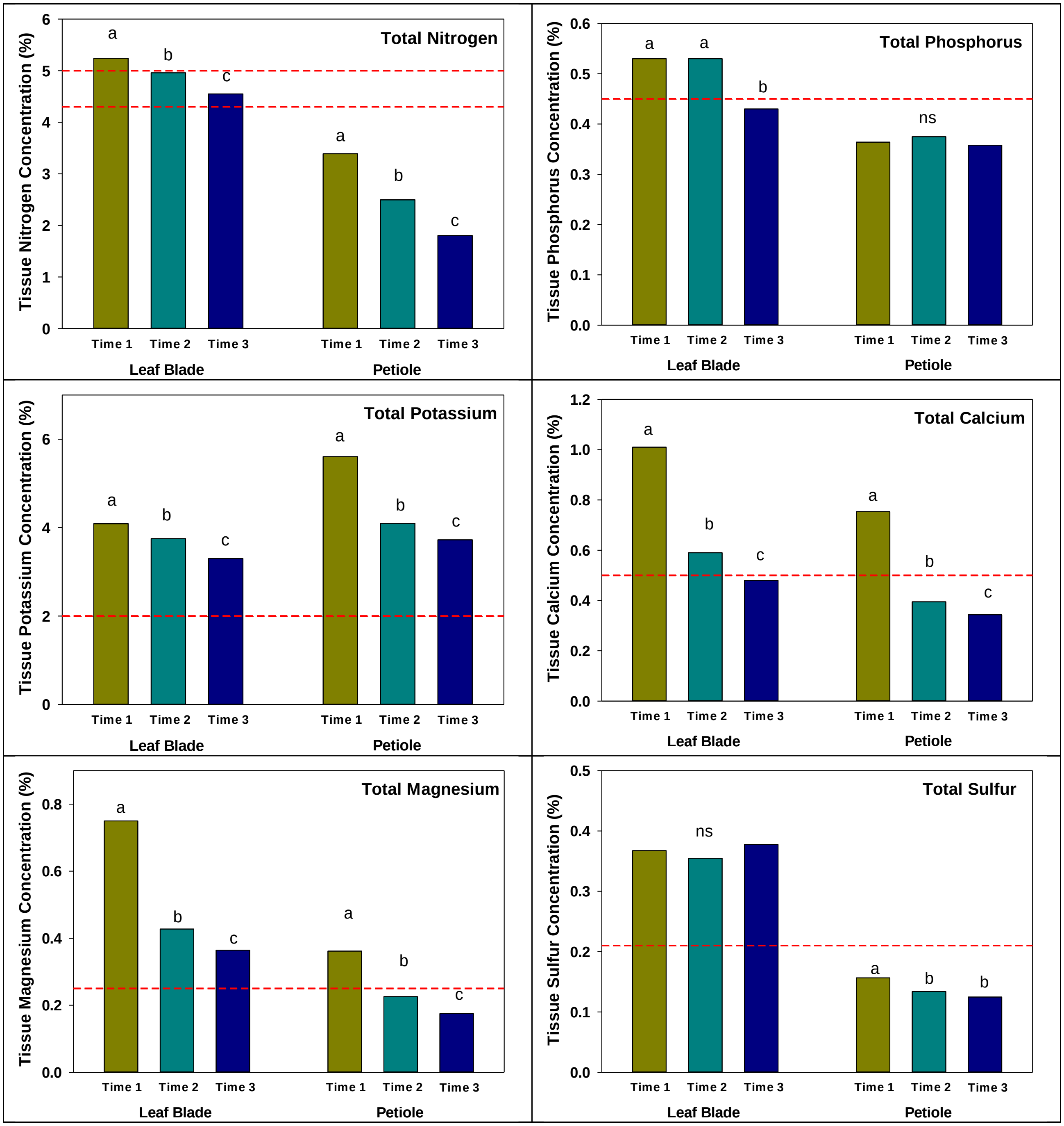

Figure 1. Summary of the impact of time on sugarbeet total macronutrient concentrations for leaf blade and petiole samples collected from six sugarbeet varieties. Letters denote significance among sampling times for leaf blade or petiole samples at $P \leq 0.10$. Horizontal dashed lines represent the upper and lower end of the sufficiency range for leaf blade samples according to Bryson et al., 2014. A single dashed line represents the low end of the sufficiency range.

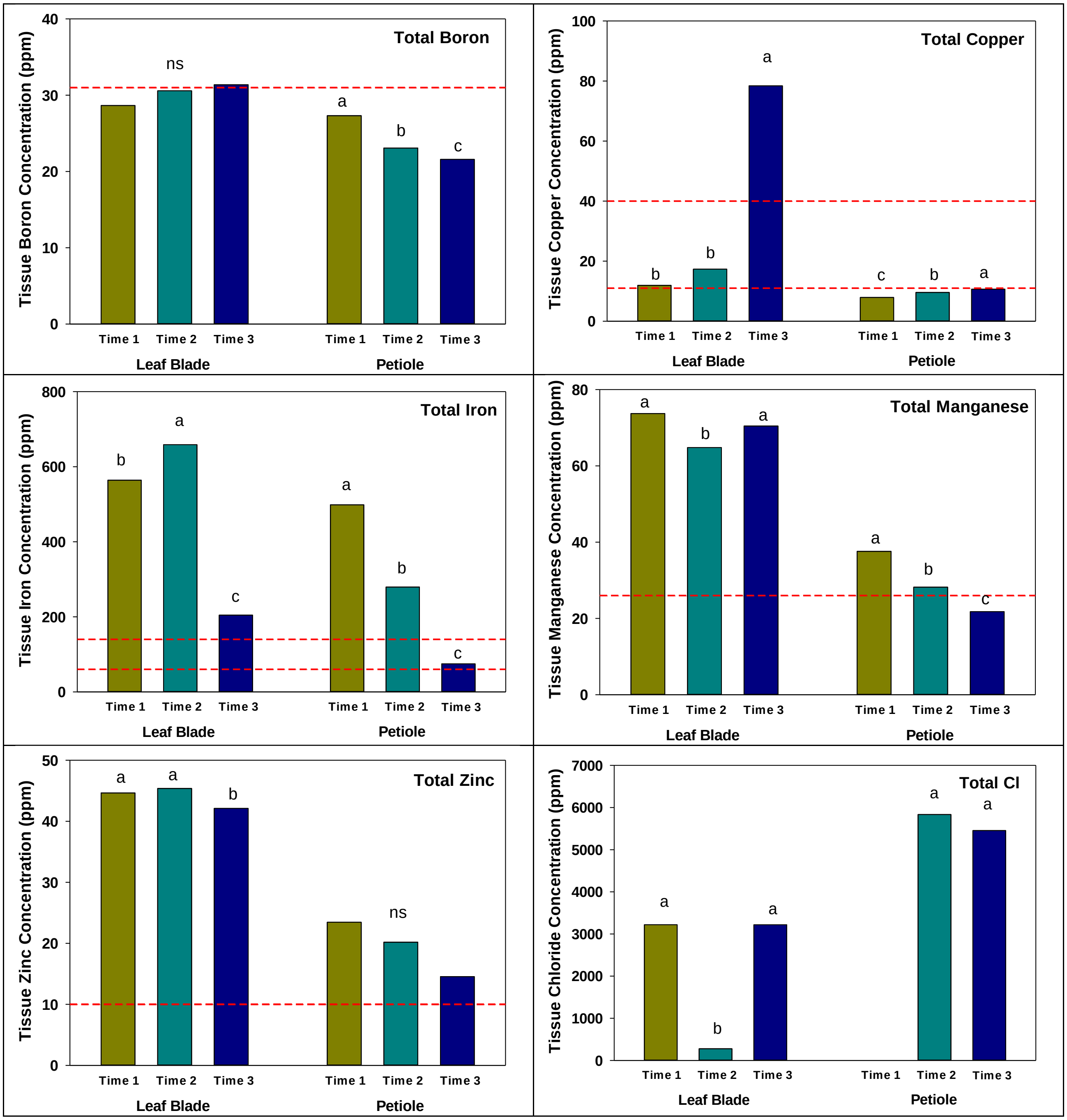

Figure 2. Summary of the impact of time on sugarbeet total micronutrient concentrations for leaf blade and petiole samples collected from six sugarbeet varieties. Letters denote significance among sampling times for leaf blade or petiole samples at *P*≤0.10. Horizontal dashed lines represent the upper and lower end of the sufficiency range for leaf blade samples according to Bryson et al., 2014. A single dashed line represents the low end of the sufficiency range.

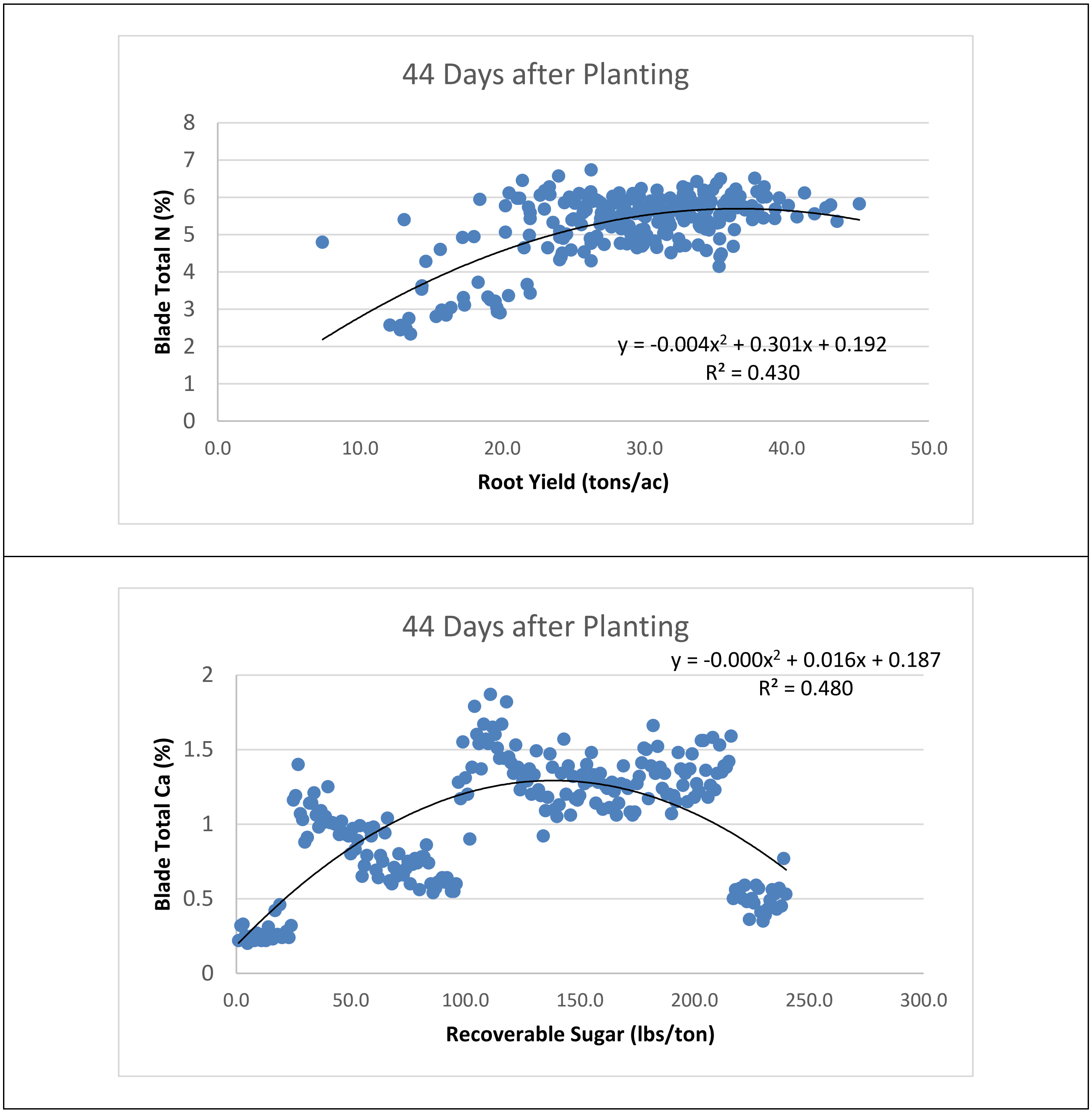

Figure 3. Relationship between blade total N concentration and root yield and blade total Ca concentration on recoverable sugar for tissue samples collected 44 days after planting.

Evaluation of Sugarbeet Response to Boron (B) on High Organic Matter Soils

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2016-2018 Research Summary Points

- Sugarbeet leaf blade B concentration was seldom impacted by the application of B indicating sufficiency supply of B from the soil on most locations
- Sugarbeet tonnage and recoverable sugar were not increased by B when applied on a fine textured soil with organic matter concentration greater than 4.0% in the top six inches.

Implications for management **–** The data presented suggests that there should be little concern that B is limiting the sugarbeet grown on high organic matter soils in Minnesota. Growers concerned about boron should target application on sandy soils. Concurrent data collected for corn (not shown) indicated a slight chance corn yield could be impacted on sandy low organic matter soils. A slight decrease in sugarbeet tonnage with increasing rate of B applied at one site should be noted as sugarbeet growers applying B should limit broadcast application rates to no more than 2 lbs per acre. Foliar application of boron was not tested and caution should be exercised when applying foliar boron to crops in order to avoid toxicity issues which can reduce the yield of crops.

Introduction

Reports of low boron concentrations in corn plant tissue have been common in recent years. There are no established guidelines for boron application for corn in Minnesota. With higher crop yield farmers are continually being marketed boron as a way to further increase yield. Plant analysis has become an increasingly larger tool used to promote the sales of boron. Critical plant tissue sufficiency levels can be easily manipulated to ensure B concentration are considered "low". Research identifying crop response as related to soil test and plant tissue boron concentration is needed to identify whether there is a direct correlation to crop yield response to the given variables. On-farm research can be useful for correlation studies to gauge the impacts of fertilizer management across varying soil properties within and across fields.

The objective of this project was to determine if boron application to sugarbeet in Minnesota will increase tonnage and quality of the crop when grown on high organic matter soils.

Materials and Methods

Sugarbeet trials were conducted from 2016 to 2018 (Table 1). Boron rates of 0, 2, 4, and 6 lbs B per acre were hand applied on the soil surface after planting to plots measuring 11' in width (6 rows 22" wide) and 40' in length. The boron source used in the trial was a 10% granular boron fertilizer material. Each treatment was replicated six times. A single composite soil sample was collected at a depth of 0-6" before fertilizer application. Boron concentration in the leaf blade was measured from each plot by sampling the newest fully developed leaf in early July approximately 60 days after planting.

Table 1 Summary of soil test data collected in 2016, 2017, and 2018 from sugarbeet trials prior to treatment application. Samples were collected from the 0-6” and are a composite of 12 separate cores per location.

			Soil Test†				B‡
Year	Location	Soil Type	P	K	pH	OM	Avg
			--ppm--			-%-	---ppm---
2016	Clara City	Bearden	10	150	7.8	6.4	1.5
2017	Clara City	Bearden	15	316	7.8	7.9	1.1
	Crookston	Wheatville	12	194	7.9	4.4	0.7
	Redwood Falls	Havelock	39	544	7.7	6.7	1.5
2018	Clara City	Bearden	15	189	7.7	6.6	2.1
	Crookston	Wheatville	11	91	8.1	2.9	0.8
	Redwood Falls	Amiret	20	198	5.6	4.1	0.7

† P, Olsen phosphorus; K, ammonium acetate extractable potassium; pH, soil pH; OM, organic matter.

Results and Discussion

Sugarbeet is considered to be more sensitive to a deficiency of B. A majority of sugarbeet acreage is grown on fine textured soils with organic matter concentrations substantial enough where B should be supplied in adequate quantities. A field study was conducted on a soil with a potential to supply a high concentration of B for the crop. The data in Table 2 shows that there was no effect of B on sugarbeet leaf blade B concentration measured in early July in 2016 and 2017 while all sites showed an increase in leaf blade B concentration in 2018. The lack of an increase in leaf B would be a good indicator of sufficient B availability from the soil in 2016 and 2017. The 2018 growing season was relatively wet (not shown) but there was no indication why leaf blade B concentration would be more responsive to B application in 2018 versus earlier growing season.

Table 2. Summary of boron leaf tissue data collected from a sugarbeet boron field study near Clara City, MN conducted in 2016 where 0, 2, 4 or 6 of B was applied after planting. Variables are considered significant at $P \leq 0.05$.

Year	Location	0	2	4	6	Significance
		------------------%B------------------				$P>F$
2016	Clara City	36.1	35.4	33.2	37.1	0.17
2017	Clara City	23.6	23.5	23.4	24.4	0.44
	Crookston	36.0	35.2	37.1	36.2	0.72
	Redwood Falls	29.2	30.5	31.2	30.5	0.42
2018	Clara City	33b	33b	34b	37a	<0.001
	Crookston	33c	36bc	40b	52a	<0.001
	Redwood Falls	37c	45bc	50b	62a	<0.001

Table 3. Summary of root yield data collected from a sugarbeet boron field study near Clara City, MN conducted in 2016 where 0, 2, 4 or 6 of B was applied after planting. Variables are considered significant at $P \leq 0.05$.

Year	Location	0	2	4	6	Significance
		------------------ tons per acre ------------------				$P>F$
2016	Clara City	24.6	26.8	25.6	26.4	0.21
2017	Clara City	39.3a	38.2ab	39.6a	37.5b	0.04
	Crookston	24.0	24.4	25.1	25.1	0.37
	Redwood Falls	35.9	36.8	36.9	36.6	0.90
2018	Clara City	21.0	18.0	18.9	19.2	0.22
	Crookston	14.6	15.7	14.0	14.8	0.47
	Redwood Falls	**Site not harvested				

Root yield data are summarized in Table 3. The only difference in sugarbeet root yield occurred at Clara City in 2017 where yield was less for the 6 lb B rate versus 0, 2, or 4 lbs B per acre. Yield decreases due to B have occurred for soybean in Minnesota but it was assumed sugarbeet would be more tolerant of high soil B than soybean. Yield levels varied from around 14 to 39 tons and there was no greater impact of B on high or low yielding situations. Yield was relatively low at Crookston due to a hail event which occurred in the middle of the summer followed by dry weather conditions. Yield data was not collected at the Redwood Falls site in 2018 due to flooding. Crop stand was significantly reduced at Redwood Falls in 2018 to a point which the site was abandoned. Recoverable sucrose was not impacted by the application of B at any location (Table 4).

Table 4. Summary of recoverable sugar data collected from a sugarbeet boron field study near Clara City, MN conducted in 2016 where 0, 2, 4 or 6 of B was applied after planting. Variables are considered significant at $P \leq 0.05$.

Year	Location	0	2	4	6	Significance
		------------------ lb per ton ------------------				P>F
2016	Clara City	266.6	265.0	264.7	270.6	0.32
2017	Clara City	287.9	288.6	286.6	289.1	0.90
	Crookston	347.3	344.4	346.2	341.3	0.89
	Redwood Falls	303.8	304.2	307.8	305.5	0.68
2018	Clara City	249.0	246.6	246.9	244.1	0.87
	Crookston	332.5	326.4	322.1	328.2	0.58
	Redwood Falls	**Site not harvested				

Conclusions

Data indicated that sugarbeet is unlikely to respond to the application of B when grown on higher organic matter soils. Boron may be deficient and may need to be applied for sugarbeet on sandy soils. However, sugarbeet response in sandy soils was not evaluated in this trial. Leaf boron concentration was not increased in two of three years indicating that boron from the fertilizer was either not available or there was enough boron in the soil to satisfy crop needs. The only impact on yield was a yield decrease due to boron application which may indicate over application does have a potential for reducing yield due to boron toxicity.

Acknowledgments

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SUGARBEET TOLERANCE AND WEED CONTROL FROM POSTEMERGENCE ETHOFUMESATE 4SC

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Introduction

Sugarbeet (*Beta vulgaris* L.) is a high value, root crop with approximately 18% sucrose content in the root (Milford 2006). Weed control is an important component in profitability of sugarbeet production (Soltani et al. 2018). Weeds can also affect sugarbeet quality by reducing sucrose percentage and decreasing the aesthetics of production fields. Ethofumesate is a broad spectrum, soil-applied herbicide for control of broadleaf and grass weeds in sugarbeet (Edwards et al. 2005). Some weed species controlled with ethofumesate are common lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), barnyardgrass (*Echinochloa crus-galli*), and wild oat (*Avena fatua* L.), which are known to reduce yield in sugarbeet (Ekins and Cronin 1972). Ethofumesate is a commonly used soil-applied herbicide, however, it can be applied postemergence at 12 fl oz/A. Generic Crop Science has developed a new Ethofumesate 4SC label that increases postemergence use rates from 12 to 128 fl oz/A to sugarbeet with greater than two true leaves. Field and greenhouse experiments were conducted in 2018 and 2019 to evaluate sugarbeet tolerance and herbicide efficacy.

Materials and Methods

Sugarbeet Tolerance

Experiments were conducted near Downer, MN, Hickson, ND, Horace, ND and Prosper, ND in 2018 and Crookston, MN, Hickson, ND, Prosper, ND, and Wolverton, MN in 2019. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was planted between May 3 and June 7 across 2018 and 2019.

Herbicide treatments were applied when sugarbeet was at the 2-lf stage 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 four rows of six row plots 30 feet long. Treatments consisted of one application of ethofumesate at 0, 8, 16, 32, 64, and 128 fl oz/A. All treatments contained Destiny HC at 1.5 pt/A which was provided by Winfield United.

Sugarbeet injury was evaluated as a visual estimate of percent growth reduction of the middle 4 rows per plot compared to the adjacent 2 untreated rows. Sugarbeet was harvested from the center two rows of the four treated rows within a plot in the fall and assessed for yield and quality. Yield components were analyzed using SAS Data Management software PROC MIXED procedure to test for significant differences at p=0.05. Experimental design was randomized complete block with 6 replications.

Ethofumesate Efficacy

Experiments were conducted on indigenous populations of common lambsquarters, redroot pigweed, and waterhemp in sugarbeet grower fields near Moorhead, Lake Lillian, and Oslo, Minnesota and Minto and Prosper, North Dakota in 2018 and 2019. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was planted between May 7 and 15 in both years.

Herbicide treatments were applied at the 2-lf sugarbeet stage. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 40 feet in length.

Sugarbeet injury and weed control was evaluated. All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications. Data were analyzed with the ANOVA procedure of ARM, version 2019.4 software package.

Results

Sugarbeet Tolerance

Sugarbeet stature reduction ranged from 0 to 28% 7 DAT (days after treatment) and 0 to 29% 14 DAT (Table 1). Stature reduction increased as ethofumesate rate increased from 8 to 128 fl oz/A. Ethofumesate at 8 and 16 fl oz/A had similar stature to the untreated check at 7, 14 and 28 DAT. Ethofumesate at 32 fl oz/A had slightly reduced stature compared to the untreated check at 7 and 14 DAT but had grown out of the injury and looked similar to the untreated check at 28 DAT. Ethofumesate at 64 and 128 fl oz/A had greater injury compared to the untreated check at 7, 14 and 28 DAT. Visible stature reduction tended to decrease throughout the growing season.

Table 1. Stature reduction in response to Ethofumesate 4SC rate across 7 environments in 2018-2019[a].

Ethofumesate[b]	**7 DAT[c]**	**14 DAT**	**28 DAT**
--fl oz/A--	-------------------	% stature reduction	-------------------
0	0 a	0 a	0 a
8	2 a	1 a	0 a
16	2 a	2 a	1 a
32	7 b	6 b	2 a
64	16 c	14 c	8 b
128	28 d	29 d	18 c
LSD (0.05)	**5**	**5**	**4**
	------------------	*P*-value	-------------------
	<0.0001	<0.0001	<0.0001

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

[b] High surfactant methylated oil concentrate at 1.5 pt/A added to each post treatment

[c] Stature reduction 7 and 14 days after treatment (DAT)

Sugarbeet root yield and sucrose content were not affected by ethofumesate rate, however, recoverable sucrose content generally decreased as ethofumesate rate increased (Table 2). Ethofumesate decreased recoverable sucrose content at 128 fl oz/A to 8,024 lbs/A compared to the untreated check at 8,484 lbs/A. While ethofumesate at 64 fl oz/A numerically decreased recoverable sucrose per acre, it was still statistically comparable to the untreated check. Root yield and sucrose content was an average of 30 tons/A and 15.6% across all treatments and environments.

Table 2. Root yield, recoverable sucrose, and sucrose content in response to Ethofumesate 4SC rate across 7 environments in 2018-2019.[a]

Ethofumesate[b]	**Root Yield[c]**	**Sucrose Content**	**Rec. Suc[d]**
--fl oz/A--	---Tons/A---	---%---	---lbs/A---
0	30	15.7	8,484 ab
8	30	15.6	8,343 abc
16	30	15.7	8,440 ab
32	31	15.7	8,511 a
64	29	15.7	8,143 bc
128	29	15.4	8,024 c
LSD (0.05)	**NS**	**NS**	**349**
	-------------------------	*P*-value	----------------------
	0.1703	0.2844	0.0410

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

[b] High surfactant methylated oil concentrate at 1.5 pt A added to each post treatment

[c] Root yield reported in tons per acre

[d] Recoverable sucrose reported in pounds per acre

Ethofumesate reduced sugarbeet stature at rates greater or equal to 32 fl oz/A, however, stature reduction decreased as time progressed. Sugarbeet stature and yield components were negatively affected by rates of ethofumesate of 64 fl oz/A or greater.

Ethofumesate Efficacy Results

Visible common lambsquarters control ranged from 43 to 100% when herbicide treatments were evaluated 7 DAT and from 26-96% 14 DAT (Table 3). Glyphosate alone gave 98 and 95% control 7 and 14 DAT, respectively. While ethofumesate at 32 and 64 fl oz/A plus glyphosate provided 100% numerical common lambsquarters control 7 DAT, adding ethofumesate with glyphosate did not significantly improve common lambsquarters control compared to glyphosate alone.

Common lambsquarters control from ethofumesate generally increased as the ethofumesate rate increased. Common lambsquarters control from 32 fl oz/A ethofumesate was greater at 7 and 14 DAT than control from 16 fl oz/A ethofumesate. However, increasing the rate from 32 to 64 or 128 fl oz/A did not consistently improve common lambsquarters control.

Table 3. Common lambsquarters visible control 7 and 14 DAT across 10 environments[a] in 2018 and 2019.

		Common Lambsquarters	
Treatment	**Rate**	**7 DAT**	**14 DAT**
	----fl oz/A----	--------------%---------------	
Glyphosate	32	98 a	95 a
Ethofumesate	16	48 e	45 e
Ethofumesate	32	70 cd	66 d
Ethofumesate	64	64 d	77 bcd
Ethofumesate	128	79 bc	84 abc
Ethofumesate + glyphosate	32 + 32	100 a	96 a
Ethofumesate + glyphosate	64 + 32	100 a	95 a
LSD (0.05)		**13**	**16**
		------------*P*-value-------------	
		<0.0001	<0.0001

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

Visible redroot pigweed control ranged from 32 to 100% when evaluated 7 DAT and 15 to 98% when evaluated 14 DAT (Table 4). Ethofumesate alone at rates ranging from 16 to 128 fl oz/A controlled 44 to 64 and 47 to 76% redroot pigweed 7 and 14 DAT, respectively. Redroot pigweed control was greater at 32 fl oz/A ethofumesate alone compared to 16 fl oz/A, 14 DAT, but control did not significantly increase as the ethofumesate rate increased.

Glyphosate alone or with ethofumesate at 32 or 64 fl oz/A provided the greatest redroot pigweed control 7 and 14 DAT, however, the addition of ethofumesate did not improve redroot pigweed control compared to the glyphosate alone at 7 DAT. Glyphosate plus ethofumesate at 32 or 64 fl oz/A tended to be better than glyphosate alone 14 DAT, suggesting the residual control benefit of mixing ethofumesate with glyphosate. Ethofumesate at 32 fl oz/A combined with glyphosate provided redroot pigweed control similar to ethofumesate at 64 fl oz/A combined with glyphosate at both 7 and 14 DAT.

Visual waterhemp control ranged from 46 to 91% and from 31 to 91% at 7 and 14 DAT, respectively (Table 5). Waterhemp control from glyphosate was 62% at 7 DAT and 53% at 14 DAT suggesting waterhemp were glyphosate resistant biotype. Ethofumesate tended to increase waterhemp control as ethofumesate rate increased. This was observed at both 7 and 14 DAT.

Waterhemp control from 64 or 128 fl oz/A ethofumesate was better than control from 16 fl oz/A ethofumesate at 7 DAT. Waterhemp control from 128 fl oz/A ethofumesate was better than 16 or 32 fl oz/A ethofumesate at 14 DAT. Ethofumesate tended to improve waterhemp control 14 DAT compared to 7 DAT, suggesting residual control. There was no difference in waterhemp control between 32 or 64 fl oz/A ethofumesate plus glyphosate at either 7 or 14 DAT. Although ethofumesate alone at 128 fl oz/A provided similar waterhemp control as compared to glyphosate plus ethofumesate, applying ethofumesate alone at 64 or 128 fl oz/A may not be an effective strategy due to less sugarbeet tolerance at higher ethofumesate rates and increased input costs from high rates of ethofumesate compared to lower rates of ethofumesate mixed with glyphosate. Glyphosate applied with ethofumesate also provides greater control of other broadleaf weeds in fields including redroot pigweed and common lambsquarters in addition to potentially controlling germinating waterhemp with susceptible alleles.

Table 4. Redroot pigweed visible control 7 and 14 DAT across 10 environments[a] in 2018 and 2019.

		Redroot Pigweed	
Treatment	**Rate**	**7 DAT**	**14 DAT**
	----fl oz/A----	-------------%--------------	
Glyphosate	32	99 a	93 ab
Ethofumesate	16	44 fg	47 e
Ethofumesate	32	50 ef	62 d
Ethofumesate	64	54 def	71 cd
Ethofumesate	128	64 cd	76 cd
Ethofumesate + glyphosate	32 + 32	99 a	98 a
Ethofumesate + glyphosate	64 + 32	100 a	99 a
LSD (0.05)		**10**	**14**
		-------------*P*-value-----------	
		<0.0001	<0.0001

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

Table 5. Waterhemp visible control 7 and 14 DAT across 10 environments[a] in 2018 and 2019.

		Waterhemp	
Treatment	**Rate**	**7 DAT**	**14 DAT**
	----fl oz/A----	---------------%----------------	
Glyphosate	32	62 bcd	53 cd
Ethofumesate	16	58 cd	65 bcd
Ethofumesate	32	63 bcd	66 bc
Ethofumesate	64	74 abc	78 ab
Ethofumesate	128	80 ab	84 a
Ethofumesate + glyphosate	32 + 32	86 a	86 a
Ethofumesate + glyphosate	64 + 32	91 a	91 a
LSD (0.05)		**18**	**16**
		-----------*P*-value------------	
		0.0001	<0.0001

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

Summary

Ethofumesate 4SC applied postemergence at rates from 8 to 128 fl oz/A did not influence sugarbeet density, root yield, or sucrose content. However, Ethofumesate 4SC significantly reduced recoverable sucrose and sugarbeet stature at 128 fl oz/A when sugarbeet tolerance experiments were combined across locations in 2018 and 2019.

Ethofumesate is not a stand-alone postemergence herbicide for common lambsquarters, redroot pigweed, or waterhemp control, however, ethofumesate can increase efficacy of postemergence glyphosate applications. Results suggest a mixture of ethofumesate at 32 fl oz/A plus glyphosate applied early POST can improve burndown and residual control of common lambsquarters, redroot pigweed, and waterhemp compared to ethofumesate or glyphosate alone. However, similar control from glyphosate alone was observed in common lambsquarters and redroot pigweed. Benefits of adding ethofumesate to an early POST glyphosate application may not become apparent until later in the growing season. Benefits of ethofumesate may not be observed if application is not timed to an activating rainfall. Additional research may be conducted to evaluate two-spray programs of glyphosate and ethofumesate.

References

Edwards D, Zinn N, Prieto R, Wyatt TJ, Brown L, Al-Mudallal A, et al. (2005) Reregistration eligibility decision for ethofumesate. Environmental Protection Agency. 738-R-05-010. https://www3.epa.gov/pesticides/chem_search/reg_actions/reregistration/red_PC-110601_1-Sep-05.pdf. Accessed: September 26, 2017

Ekins WL, Cronin CH (1972) NC 8438, a promising new broad spectrum herbicide for sugarbeet. J Amer Soc of Sugar Beet Technol 17:134-143

Milford GFJ (2006) Plant structure and crop physiology. Page 30 in Draycott AP ed. Sugarbeet. United Kingdom: Blackwell Publishing Ltd

Soltani N, Dille A, Robinson DE, Sprague CL, Morishita DW, Lawrence NC, Kniss AR, Jha P, Felix J, Nurse RE, and Sikkema PH (2018) Potential yield loss in sugar beet due to weed interference in the United States and Canada. Weed Tech 32:749-753

Ro-Neet and Eptam Weed Efficacy and Sugarbeet Tolerance

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Introduction

Sugarbeet yield loss to weed interference averaged 70% in sugarbeet growing areas in North America (Soltani et al. 2018). This equates to about $211 and $369 million loss of income from sugarbeet production in North Dakota and Minnesota, respectively. Cycloate, pyrazon, ethofumesate, and EPTC were applied preplant incorporated (PPI) or preemergence (PRE) for weed control in sugarbeet fields in the Red River Valley and Michigan from 1970 to the mid-1980s (Dale et al. 2006). However, use of soil-applied herbicides declined to less than 5% of sugarbeet acres in North Dakota and Minnesota in the mid-1980s because of reliance on POST herbicides and cultivation (Luecke and Dexter 2003). Weeds continue to be a major concern due to limited herbicide options within sugarbeet. EPTC and cycloate could reemerge as important herbicides for weed control.

The objective of this experiment was to evaluate weed control and sugarbeet tolerance from Ro-Neet and Eptam alone or in mixtures.

Materials and Methods

Experiments were conducted on natural weed populations and bioassay species strips near Hickson, ND in 2015, 2016, 2018, and 2019. The experimental area was prepared for planting by applying the appropriate fertilizer and tillage. Sugarbeet was seeded in 22-inch rows at 60,560 seeds per acre with 4.7 inch spacing between seeds.

Herbicide treatments included PPI applications of Ro-Neet, Eptam, and Ro-Neet + Eptam at multiple rates in 2015, 2016, 2018 (Table 1) and 2019 (Table 2). All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 35 feet in length. Herbicides were immediately incorporated using a rototiller set 3 to 4 inches deep. The center 8 feet of each plot was rototilled to remove the variability that could otherwise be caused by the incorporating tillage.

Table 1. Herbicide treatments, rates, and application timing in trials near Hickson, ND in 2015, 2016, and 2018.

Herbicide Treatment	Rate (pt/A)	Timing of Application
Ro-Neet SB	4.5	PPI
Ro-Neet SB	5.36	PPI
Ro-Neet SB + Eptam	2.67 + 2.29	PPI
Ro-Neet SB + Eptam	4.5 + 2.29	PPI
Eptam	3.5	PPI

Table 2. Herbicide treatments, rates, and application timing in trials near Hickson, ND in 2019.

Herbicide Treatment	Rate (pt/A)	Timing of Application
Ro-Neet SB	4.5	PPI
Ro-Neet SB	5.36	PPI
Ro-Neet SB + Eptam	2.67 + 2.29	PPI
Ro-Neet SB + Eptam	4.5 + 2.29	PPI
Eptam	3.5	PPI
Eptam	2.5	PPI

Sugarbeet tolerance and grass and broadleaf weed control were evaluated visually, beginning approximately seven days after sugarbeet emergence. Sugarbeet emergence date was dependent on growing conditions in each year. Evaluations generally were on weekly intervals following the first evaluation and continued until weeds overtook the plots. Sugarbeet injury and common lambsquarters, redroot pigweed, foxtail millet, and oat control was evaluated in 2019. 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 4 replications. Data were analyzed with the ANOVA procedure of ARM, version 2019.4 software package.

Results

Eptam and Ro-Neet Across Years

Sugarbeet injury was greater or tended to be greater from Eptam or Ro-Neet SB plus Eptam compared to Ro-Neet SB alone at 4.5 or 5.36 pt/A. (Table 3). Sugarbeet injury from Ro-Neet SB + Eptam at 2.67 + 2.29 pt/A was the same as sugarbeet injury from Ro-Neet SB + Eptam at 4.5 + 2.29 pt/A. Injury tended to decrease from 7 days after emergence (DAE) to 28 DAE.

Table 3. Sugarbeet injury 7, 14, and 28 days after emergence (DAE) combined across years.

		Sugarbeet Growth Reduction		
Treatment	Rate	7 DAE	14 DAE	28 DAE
	--pt/A--	-------------------%---------------------		
Ro-Neet SB	4.5	18	5 a	3 a
Ro-Neet SB	5.36	20	6 a	10 ab
Ro-Neet SB + Eptam	2.67 + 2.29	44	32 b	26 bc
Ro-Neet SB +Eptam	4.5 + 2.29	50	33 b	31 c
Eptam	3.5	48	43 b	30 c
LSD (0.05)		NS	13	16

Redroot pigweed control from Eptam alone or Ro-Neet SB + Eptam was greater than pigweed control from Ro-Neet SB alone (Table 4). There was no statistical difference in control between Eptam at 3.5 pt/A and Ro-Neet SB + Eptam at 2.67 + 2.29 pt/A or Ro-Neet SB + Eptam at 4.5 + 2.29 pt/A. However, numeric control tended to be greatest from Ro-Neet SB + Eptam at 4.5 + 2.29 pt/A. Redroot pigweed control from Ro-Neet SB at 5.36 pt/A was greater than pigweed control from Ro-Neet at 4.5 pt/A. However, control was less than Eptam or Ro-Neet SB plus Eptam treatments. Treatments that gave the greatest pigweed control 7 DAE also gave the greatest control 14 and 28 DAE. However, control tended to decline as time progressed. Oat control from Eptam or Ro-Neet SB plus Eptam was greater than 95% across all evaluation timings. Oat control from Ro-Neet SB at 4.5 or 5.36 pt/A was less than control from Ro-Neet SB + Eptam at either 2.67 or 4.5 pt/A + 2.29 pt/A.

Table 4. Redroot pigweed and wild oat control 7, 14, and 28 days after emergence (DAE) combined across years.

		Redroot Pigweed Control			Wild Oat Control		
Treatment	Rate	7 DAE	14 DAE	28 DAE	7 DAE	14 DAE	28 DAE
	--pt/A--	----------------------------------		-%-	-------------------------------		
Ro-Neet SB	4.5	74 c	61 c	34 b	66 c	60 b	49 c
Ro-Neet SB	5.36	81 b	72 b	41 b	82 b	74 b	66 b
Ro-Neet SB + Eptam	2.67 + 2.29	94 a	89 a	73 a	100 a	97 a	97 a
Ro-Neet SB + Eptam	4.5 + 2.29	95 a	93 a	82 a	98 a	98 a	98 a
Eptam	3.5	92 a	88 a	73 a	99 a	98 a	98 a
LSD (0.05)		4	6	16	12	16	12

This ‘across years summary’ indicates redroot pigweed and oat control were greatest from Eptam alone or Ro-Neet SB + Eptam and not from Ro-Neet SB alone. With treatments containing Ro-Neet SB + Eptam, increasing the rate of Ro-Neet SB from 2.67 to 4.5 pt/A did not provide a statistical improvement in weed control. However, there was greater sugarbeet injury with Eptam alone or Eptam + Ro-Neet SB as compared to Ro-Neet SB alone (Table 3). Previous research and recommendations indicated tank-mixing Ro-Neet SB + Eptam was a technique to improve grass and broadleaf control and to decrease sugarbeet injury, especially shortly after planting (personal communication with A. Dexter). However, we did not observe improved sugarbeet safety with Ro-Neet SB + Eptam compared to Eptam alone in these trials

Eptam and Ro-Neet 2019

Sugarbeet injury was least with Ro-Neet SB at 4.5 pt/A or Ro-Neet SB + Eptam at 2.67 + 2.29 pt/A (Table 5). Injury was primarily stature reduction compared to the untreated rows due to delayed emergence. Injury tended to decrease as time progressed but was still evident 28 DAE. However, environmental conditions may have influenced sugarbeet injury. Rainfall was very abundant in July following dry conditions after planting and may have confounded early season stature reduction.

Table 5. Sugarbeet injury 7, 14, and 28 days after emergence (DAE) in 2019.

		Sugarbeet Growth Reduction		
Treatment	Rate	7 DAE	14 DAE	28 DAE
	--pt/A--	---------------------%---------------------		
Ro-Neet SB	4.5	33 ab	29 a	24 ab
Ro-Neet SB	5.36	51 c	45 b	41 bc
Ro-Neet SB + Eptam	2.67 + 2.29	30 a	28 a	15 a
Ro-Neet SB + Eptam	4.5 + 2.29	44 bc	26 a	26 ab
Eptam	3.5	48 c	35 ab	45 c
Eptam	2.5	43 bc	38 ab	40 bc
LSD (0.05)		12	15	17

We evaluated redroot pigweed, common lambsquarters, foxtail millet and oat control in 2019 (Table 6). Common lambsquarters density was not as uniform as the redroot pigweed and is reflected in the evaluations. Eptam at 2.5 and 3.5 pt/A, Ro-Net SB + Eptam at 4.5 + 2.29 pt/A and Ro-Neet SB + Eptam at 2.67 + 2.29 pt/A provided or tended to provide redroot pigweed control greater than Ro-Neet SB alone 14 DAE. Eptam at both rates provided greater than 90% visible redroot pigweed control 25 DAE (data not presented). Eptam or Ro-Neet SB + Eptam across rates controlled foxtail millet better than Ro-Neet SB alone. No differences in common lambsquarters control were observed from Eptam rate. Eptam alone or Eptam + Ro-Neet SB provided oat control greater than Ro-Neet SB alone. No statistical difference in oat control was observed between Eptam at 2.5 and 3.5 pt/A at either 7 or 14 DAE. Likewise, oat control from Ro-Neet SB + Eptam at 2.67 + 2.29 pt/A was the same as oat control from Ro-Neet SB + Eptam at 4.5 + 2.29 pt/A. Eptam at 3.5 pt/A gave or tended to give better foxtail millet control than Eptam at 2.5 pt/A. Foxtail millet control was best with Eptam alone or Ro-Neet SB + Eptam. Ro-Neet SB at either 4.5 or 5.36 pt/A was more effective at controlling foxtail millet than oat. Eptam was similar efficacy on both foxtail millet and oat.

Table 6. Redroot pigweed, common lambsquarters, foxtail millet, and wild oat control at 7 and 14 days after emergence (DAE) in 2019.

		7 DAE				14 DAE			
Treatment	Rate	rrpw[a]	colq	fxmi	oat	rrpw	colq	fxmi	oat
	--pt/A--	----------------------------------%---------------------------------							
Ro-Neet SB	4.5	65 c	50 b	81 bc	43 c	66 c	84	96 b	48 c
Ro-Neet SB	5.36	70 bc	81 a	80 c	53 b	78 b	88	96 b	63 b
Ro-Neet SB + Eptam	2.67 + 2.29	88 a	75 ab	89 ab	89 a	88 ab	90	98 ab	96 a
Ro-Neet SB + Eptam	4.5 + 2.29	91 a	85 a	89 a	90 a	91 a	93	97 ab	95 a
Eptam	3.5	87 a	81 a	92 a	93 a	92 a	92	99 a	97 a
Eptam	2.5	76 b	80 a	80 c	85 a	87 ab	91	99 a	96 a
LSD (0.05)		9	18	8	8	11	NS	2	4

[a] Weed species abbreviations (left to right): rrpw=redroot pigweed, colq=common lambsquarters, fxmi=foxtail millet.

References

Dale TM, Renner KA, Kravchenko AN (2006) Effect of herbicides on weed control and sugarbeet (Beta vulgaris) yield and quality. Weed Sci 20:150-156

Luecke JL and Dexter AG (2003) Survey of weed control and production practices on sugarbeet in eastern North Dakota and Minnesota. Sugarbeet Res Ext Rep. 33:35-38

Soltani N, Dille A, Robinson DE, Sprague CL, Morishita DW, Lawrence NC, Kniss AR, Jha P, Felix J, Nurse RE, and Sikkema PH (2018) Potential yield loss in sugar beet due to weed interference in the United States and Canada. Weed Technol 32:749-753

INTEGRATING HERBICIDES AND INTER-ROW CULTIVATION

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Introduction

The spread of glyphosate resistant waterhemp in Minnesota and North Dakota has sugarbeet growers looking into weed control methods that will supplement chemical control.

Materials and Methods

An experiment was conducted on common lambsquarters and waterhemp near Moorhead, MN in 2019. The trial site was prepared for planting using a Kongskilde s-tine field cultivator on May 9, 2019. 'CR 355' sugarbeet was planted in 22-inch rows at 61,500 seeds per acre on May 10 with a six-row planter. Preemergence (PRE) treatments were applied May 10. Postemergence (POST) treatments were applied June 6 and 19. All herbicide treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 30 feet in length. A maintenance application of Roundup PowerMax at 22 fl oz/A was applied to the entire trial site on June 13 to reduce competition from common lambsquarters and allow waterhemp emergence. Cultivation treatment was applied June 25 to the center 4 rows of appropriate plots. The cultivator was operated at 4 mph, set 1 to 1.5 inches deep, and equipped with sweeps that tilled 15 inches of soil surface between rows. Sugarbeet injury and common lambsquarters control were evaluated June 6, 26, July 15, and August 9, 2019. Waterhemp control was evaluated June 26, July 15, and August 9. Sugarbeet were harvested September 20 by defoliating the center 4 rows of 30' long plots and harvesting the center 2 rows with a two-row sugarbeet harvester. Sugarbeets were weighed and a subsample of about 25 lbs. of normal, representative roots from each plot were collected and taken to the American Crystal Tare Lab in East Grand Forks, MN for quality analysis.

Table 1. Application Information – Moorhead, MN 2019

Application	A	B	C	Cultivation
Date	May 10	June 6	June 19	June 25
Time of Day	6:00 PM	9:00 AM	12:30 PM	
Air Temperature (F)	64	77	76	
Relative Humidity (%)	26	42	44	
Wind Velocity (mph)	10	2	2	
Wind Direction	SW	NW	SE	
Soil Temp. (F at 6")	50	68	66	
Soil Moisture	Good	Good	Good	Sli Wet
Cloud Cover (%)	80	0	0	
Sugarbeet Stage	PRE	2-lf	8-lf	12-lf
Common Lambsquarters	PRE	1 in	3 in	
Waterhemp	PRE	0 in	3 in	

All sugarbeet injury and weed control evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. The experiment was a 2x4 factorial split-block arrangement in a randomized complete block design with 4 replications. Each replication (block) was "grid split" where the factor A was cultivation at two levels and the factor B was herbicide at four levels. Data were analyzed with the ANOVA procedure of ARM, version 2019.4, software package.

Results

Cultivation (factor A) had no impact on sugarbeet injury at either evaluation (Table 2). Herbicide (factor B) had no impact on sugarbeet injury at either evaluation.

Table 2. Sugarbeet Injury at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Percent Sugarbeet Injury	
	(fl oz/A)		June 6	June 26
FACTOR A - Cultivation				
NO Cultivation	-	-	9	8
Cultivation	-	Cultivation	8	7
FACTOR A LSD (0.05)			**NS**	**NS**
FACTOR B - Herbicide				
Dual Magnum	8	A	7	3
Dual Magnum fb	8 fb	A fb		
POST[1] + Outlook fb	1x[2] + 18 fb	B fb	8	8
POST	1x	C		
Dual Magnum fb	8 fb	A fb		
POST fb	1x fb	B fb	13	9
POST + Outlook	1x + 18	C		
Dual Magnum fb	8 fb	A fb		
POST + Outlook fb	1x + 12 fb	B fb	7	11
POST + Outlook	1x + 12	C		
FACTOR B LSD (0.05)			**NS**	**NS**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

Cultivation (factor A) had no significant impact on common lambsquarters control at any evaluation timing (Table 3). Herbicide (factor B) significantly impacted common lambsquarters control at all evaluations taken after all herbicide application timings were completed. Dual Magnum at 0.5 pt/A was applied PRE on all plots and gave 68% to 78% control of common lambsquarters. Plots receiving two applications of POST herbicides following PRE Dual Magnum showed 97% to 99% lambsquarters control later in the season compared to 38% to 70% control in plots receiving only PRE Dual Magnum. Cultivation did not impact common lambsquarters control when POST herbicides were applied (data not shown), but PRE Dual Magnum followed by cultivation tended to give 15% to 20% greater common lambsquarters control compared to PRE Dual Magnum without cultivation (data not shown).

Table 3. Common Lambsquarters Control at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Percent Common Lambsquarters Control			
	(fl oz/A)		June 6	June 26	July 15	August 8
FACTOR A - Cultivation						
NO Cultivation	-	-	72	85	88	86
Cultivation	-	Cultivation	70	81	94	90
FACTOR A LSD (0.05)			**NS**	**NS**	**NS**	**NS**
FACTOR B - Herbicide						
Dual Magnum	8	A	68	38	70	55
Dual Magnum fb	8 fb	A fb				
POST[1] + Outlook fb	1x[2] + 18 fb	B fb	78	99	98	99
POST	1x	C				
Dual Magnum fb	8 fb	A fb				
POST fb	1x fb	B fb	69	97	97	99
POST + Outlook	1x + 18	C				
Dual Magnum fb	8 fb	A fb				
POST + Outlook fb	1x + 12 fb	B fb	70	99	99	99
POST + Outlook	1x + 12	C				
FACTOR B LSD (0.05)			**NS**	**11**	**11**	**8**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

Cultivation (factor A) had no significant impact on waterhemp control at June and July evaluation timings (Table 4). The August evaluation showed cultivation gave an improvement in waterhemp control compared to no cultivation, though the difference was slight. Herbicide (factor B) significantly impacted waterhemp control at all evaluations. Dual Magnum at 0.5 pt/A was applied PRE and gave 41% to 74% control of waterhemp. Plots receiving two applications of POST herbicides following PRE Dual Magnum showed 96% to 99% waterhemp control. Cultivation did not impact waterhemp control when POST herbicides were applied (data not shown), but PRE Dual Magnum followed by cultivation tended to give 10% to 15% greater waterhemp control compared to PRE Dual Magnum without cultivation (data not shown).

Table 4. Waterhemp Control at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Percent Waterhemp Control		
	(fl oz/A)		June 26	July 15	August 8
FACTOR A - Cultivation					
NO Cultivation	-	-	85	89	87
Cultivation	-	Cultivation	82	95	91
FACTOR A LSD (0.05)			**NS**	**NS**	**3.3**
FACTOR B - Herbicide					
Dual Magnum	8	A	41	74	62
Dual Magnum fb POST[1] + Outlook fb POST	8 fb 1x[2] + 18 fb 1x	A fb B fb C	96	99	98
Dual Magnum fb POST fb POST + Outlook	8 fb 1x fb 1x + 18	A fb B fb C	98	97	99
Dual Magnum fb POST + Outlook fb POST + Outlook	8 fb 1x + 12 fb 1x + 12	A fb B fb C	99	99	99
FACTOR B LSD (0.05)			**16**	**10**	**7**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

Impacts of cultivation and herbicide on yield followed a very similar trend as has been discussed with respect to weed control. Cultivation (factor A) had no significant impact on yield parameters (Table 5). There is a slight numeric trend towards greater root yield (1.3 ton/A) and greater extractable sucrose (353 lb/A) from cultivation, but the impact was not statistically significant. Herbicide (factor B) significantly impacted root yield, but did not impact sugar percentage or extractable sucrose per acre. Dual Magnum at 0.5 pt/A applied PRE gave 27.0 ton/A root yield, while plots receiving two applications of POST herbicides following PRE Dual Magnum gave 29.9 to 31.3 tons/A. Cultivation did not impact root yield or extractable sucrose when POST herbicides were applied (data not shown), but PRE Dual Magnum followed by cultivation gave 6.2 tons/A greater root yield and 1,200 lbs/A greater extractable sucrose compared to PRE Dual Magnum without cultivation (data not shown).

Conclusions

Common lambsquarters was very dense in this trial in late May and early June and was actually suppressing waterhemp germination. Waterhemp started to emerge following an across trial application of Roundup PowerMax at 22 fl oz/A on June 13. The main influence on weed control as the season progressed was not cultivation, but rather Outlook herbicide. For both common lambsquarters and waterhemp, the greatest control was observed when Outlook was applied early POST (2 leaf), late POST (8 leaf), or as a split application at both timings. Due to the early season interference from common lambsquarters, waterhemp emergence was delayed and both POST timings of Outlook were effective at controlling waterhemp. The broadcast application of Roundup PowerMax at 22 fl oz/A allowed us to observe the PRE followed by a single POST application system. This system was not effective at controlling either waterhemp or common lambsquarters under very dense weed pressure. Higher rates of Roundup may have improved common lambsquarters control, but increased rates of POST applied glyphosate would not have improved control of the glyphosate-resistant waterhemp.

Table 5. Yield Impacts from cultivation and herbicide at Moorhead, MN, 2019.

Treatment	Rate	Timing[3]	Yield	Sugar	Ext. Sucrose
	(fl oz/A)		Ton/A	%	Lb/A
FACTOR A - Cultivation					
NO Cultivation	-	-	29.1	13.7	7,154
Cultivation	-	Cultivation	30.4	13.7	7,507
FACTOR A LSD (0.05)			**NS**	**NS**	**NS**
FACTOR B - Herbicide					
Dual Magnum	8	A	27.0	13.7	6,679
Dual Magnum fb POST[1] + Outlook fb POST	8 fb 1x[2] + 18 fb 1x	A fb B fb C	30.7	13.6	7,485
Dual Magnum fb POST fb POST + Outlook	8 fb 1x fb 1x + 18	A fb B fb C	29.9	13.9	7,485
Dual Magnum fb POST + Outlook fb POST + Outlook	8 fb 1x + 12 fb 1x + 12	A fb B fb C	31.3	13.7	7,673
FACTOR B LSD (0.05)			**3.5**	**NS**	**NS**

[1] POST = Roundup PowerMax @ 28 fl oz/A + Ethofumesate 4SC @ 6 fl oz/A + Destiny HC @ 1.5 pt/A + NPak AMS at 2.5% v/v

[2] 1x = rates specified in footnote 1.

[3] Timing refers to application timings in Table 1.

The impact of cultivation on weed control was skewed in this trial. In the plots that received only Dual Magnum PRE, weed pressure was quite heavy. It was in these weedy plots that we observed the greatest impact from cultivation on weed control. This observation is logical and supports what we've known for many years: cultivation in weedy fields generally helps eliminate some weeds and typically improves overall weed control. The weed pressure was lighter in the plots that received POST herbicides and there was less benefit from cultivation. However, no negative effects from cultivation such as increased root disease was observed. Likewise, cultivation did not negatively affect Outlook, which to be effective, must be evenly distributed in the top inch of the soil horizon for weeds to absorb the herbicide and to be controlled.

TURNING POINT SURVEY OF WEED CONTROL AND PRODUCTION PRACTICES IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2018

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The fourth annual weed control and production practices live polling questionnaire was conducted using Turning Point Technology at the 2019 winter Sugarbeet Grower Seminars. Responses are based on production practices from the 2018 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 193,050 acres reported by 277 respondents (Table 6) compared to 198,500 acres represented in 2017. The average sugarbeet acreage per respondent grown in 2018 was calculated from Table 6 at 697 acres compared to 634 acres in 2017.

Survey participants were asked a series of questions regarding their production practices used in sugarbeet in 2018. Fifty-four percent of respondents indicated wheat was the crop preceding sugarbeet (Table 7), 23% indicated corn, and 13% indicated soybean. Preceding crop varied by location with 84% of Grand Forks growers indicating wheat preceded sugarbeet and 73% of Willmar growers indicated corn as their preceding crop. Seventy-seven percent of growers who participated in the winter meetings used a nurse or cover crop in 2018 (Table 8) which increased from 74% in 2017. Cover crop species also varied widely by location with barley being used by 63% of growers at the Fargo meeting and oat being used by 46% of growers at the Willmar meeting.

Growers indicated Cercospora Leaf Spot (CLS) was their most serious production problem in sugarbeet in 2018 (Table 9) with 42% of all respondents naming CLS compared to Rhizoctonia being named most serious problem by 27% of participants in 2017. In 2018, Rhizoctonia was the most serious problem for 22% of respondents and weeds were named as most serious by 14% of respondents.

Waterhemp was named as the most serious weed problem in sugarbeet in 2018 by 54% of respondents (Table 10) compared to 48% in 2017. Six percent of respondents indicated common lambsquarters, 9% kochia, and 18% said common ragweed were their most serious weed problem in 2018. 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 91%, 90%, and 81% 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 46% of responses.

Respondents to the survey indicated making 0 to 5 glyphosate applications in their 2018 sugarbeet crop (Table 11) with a calculated average of 2.16 applications per acre. The calculated average in 2017 was 2.21 applications per acre.

Glyphosate was most commonly applied with a broadleaf herbicide postemergence in 2018 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 2018 with 30% of responses. Glyphosate alone and glyphosate plus a grass herbicide were the third and fourth most common at 24% and 8% of the responses.

Satisfaction to weed control from glyphosate applied alone is shown in Table 13 and ranged from 17% of responses indicating excellent control to 6% of responses indicating poor weed control. The majority of responses, 40%, indicated glyphosate was still providing good weed control in sugarbeet in 2018.

Preplant incorporated (PPI) or preemergence (PRE) herbicides were applied by 46% of survey respondents in 2018 (Table 14). Less than 10% of Grand Forks survey participants applied a PPI or PRE herbicide. Conversely, 89% of Wahpeton survey participants did apply a PPI or PRE herbicide in sugarbeet in 2018 compared to 83% in 2017. Once again, a likely reason for this variation is the more common presence of glyphosate-resistant waterhemp in the southern sugarbeet growing areas of the Red River Valley compared to the north end of the Valley. The most commonly used soil herbicide was S-metolachlor with 25% of all responses followed by ethofumesate with 9% of responses (Table 14). Of the growers who indicated using a soil-applied herbicide, 67% indicated excellent to good weed control from that herbicide (calculated from Table 15).

The application of soil-residual herbicides applied 'lay-by' to the 2018 sugarbeet crop was indicated by 63% of respondents (Table 16). Outlook was the most commonly applied lay-by herbicide with 31% of responses. The majority of growers responding at the Willmar meeting indicated using Outlook (69% of responses), while S-metolachlor was more commonly applied by growers of the Wahpeton (68% of responses) and Fargo (64% of responses) meetings. Ninety-five percent, 95%, and 82% of Willmar, Wahpeton, and Fargo respondents, respectfully, applied glyphosate with Outlook, S-metolachlor, or Warrant but only 21% and 6% 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 glyhphosate-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, 73% indicated excellent or good weed control (calculated from Table 17).

Fifty-eight percent of survey respondents indicated using some form of mechanical weed control or hand labor in 2018 (Table 18). Of the responses given, 39% indicated at least some hand-weeding, 15% used row-cultivation, and 1% indicated using a rotary hoe for weed control in sugarbeet. Fifteen percent reported row-crop cultivation on less than ten percent of their acres (Table 19).

Hand-weeding the 2018 sugarbeet crop was reported by 54% of respondents (Table 20). 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. 2019 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2018.

County		Number of Responses	Percent of Responses
Becker		1	3
Cass		12	32
Clay		10	26
Norman[1]		12	32
Richland		2	4
Traill		1	3
	Total	38	100

[1] Includes Mahnomen County

Table 2. 2019 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2018.

County	Number of Responses	Percent of Responses
Grand Forks	3	8
Kittson	5	13
Marshall	2	5
Pembina	13	33
Walsh	14	36
Other	2	5
Total	39	100

Table 3. 2019 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2018.

County	Number of Responses	Percent of Responses
Grand Forks	19	21
Mahnomen	1	1
Marshall	9	10
Pennington[1]	1	1
Polk	45	51
Traill	2	2
Walsh	4	5
Other	8	9
Total	89	100

[1] Includes Red Lake

Table 4. 2019 Wahpeton Grower Seminar - Number of survey respondents by county growing sugarbeet in 2018.

County	Number of Responses	Percent of Responses
Clay	3	10
Grant	4	13
Richland	6	20
Traverse	1	3
Wilkin	16	54
Total	30	100

Table 5. 2019 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2018.

County	Number of Responses	Percent of Responses
Chippewa	27	33
Kandiyohi	8	10
Pope	1	1
Redwood	4	5
Renville	26	32
Stevens	5	6
Swift	6	8
Other	4	5
Total	81	100

Table 6. Total sugarbeet acreage operated by respondents in 2018.

		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	36	6	6	8	2	28	17	6	8	11	8
Grafton	42	5	14	0	10	33	14	17	5	2	0
Grand Forks	83	11	7	5	4	16	20	7	17	8	5
Wahpeton	30	7	3	0	30	20	10	7	13	7	3
Willmar	82	7	12	10	6	17	18	4	15	10	1
Total	273	8	9	5	8	21	17	7	13	8	4

Table 7. Crop grown in 2017 that preceded sugarbeet in 2018.

		Previous Crop								
Location	Responses	Barley	Canola	Sweet Corn	Field Corn	Dry Bean	Potato	Soybean	Wheat	Other
		-------% of responses-------								
Fargo	37	11	0	0	0	0	0	22	67	0
Grafton	44	0	0	0	0	7	9	7	77	0
Grand Forks	86	3	0	0	1	3	6	3	84	0
Wahpeton	30	0	0	0	13	3	0	17	67	0
Willmar	82	0	0	5	73	1	0	20	0	1
Total	279	2	0	1	23	3	3	13	54	<1

Table 8. Nurse or cover crop used in sugarbeet in 2018.

Location	Responses	Barley	Oat	Rye	Wheat	Other[1]	None
		-------% of responses-------					
Fargo	38	63	3	0	8	0	26
Grafton	45	24	11	0	29	0	36
Grand Forks	93	44	0	1	25	0	30
Wahpeton	28	54	0	0	36	0	10
Willmar	83	2	46	3	37	0	12
Total	287	32	15	2	28	0	23

[1] Includes Mustard and 'Other'

Table 9. Most serious production problem in sugarbeet in 2018.

Location	Responses	CLS[1]	Rhizo-mania	Aph[2]	Rhizoc-tonia	Fusarium	Herbicide Injury	Root Maggot	Weeds	Stand[3]
		-------% of responses-------								
Fargo	38	26	0	5	32	0	3	0	26	8
Grafton	43	16	0	14	26	0	5	18	16	5
Grand Forks	84	32	2	8	24	1	1	4	16	12
Wahpeton	31	55	0	0	16	3	0	0	10	16
Willmar	82	68	1	3	16	0	0	0	7	5
Total	278	42	1	6	22	<1	1	4	14	9

[1] Cercospora Leaf Spot

[2] Aphanomyces

[3] Emergence/Stand

Table 10. Most serious weed problem in sugarbeet in 2018.

Location	Responses	biww[1]	colq	cora	kochia	gira	rrpw	RR Canola	wahe
		-----------------------------------% of responses--------------------------							
Fargo	38	3	0	8	5	3	0	0	81
Grafton	46	2	13	11	21	2	20	11	20
Grand Forks	87	0	10	46	15	9	5	1	14
Wahpeton	29	0	0	7	3	0	0	0	90
Willmar	80	0	4	0	0	4	0	1	91
Total	280	<1	6	18	9	5	5	2	54

[1] biww=biennial wormwood, 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 2018 season.

Location	Responses	0	1	2	3	4	5
		-------------------------% of responses---------------------------					
Fargo	38	0	16	63	21	0	0
Grafton	43	0	7	65	28	0	0
Grand Forks	86	1	13	57	27	1	1
Wahpeton	30	0	10	57	33	0	0
Willmar	80	0	19	54	24	1	2
Total	277	<1	14	57	26	<1	1

Table 12. Herbicides used in a weed control systems approach in sugarbeet in 2018.

		Glyphosate Application Tank-Mixes					
Location	Responses	Gly Alone	Gly+Lay-by	Gly+Broadleaf	Gly+Grass	Other	None Used
		-------------------------------------% of responses----------------------------------					
Fargo	37	19	35	38	5	3	0
Grafton	39	67	0	28	0	3	3
Grand Forks	83	33	2	57	1	5	2
Wahpeton	30	7	50	33	10	0	0
Willmar	79	3	65	10	19	3	1
Total	268	24	30	34	8	3	1

Table 13. Satisfaction in weed control from glyphosate applied in sugarbeet in 2018.

		Satisfaction of Weed Control from Glyphosate					
Location	Responses	Excellent	Good	Fair	Poor	Unsure	Not Used Alone
		---------------------------------% of responses----------------------------					
Fargo	39	5	26	46	13	0	10
Grafton	41	37	56	7	0	0	0
Grand Forks	79	20	43	16	4	3	14
Wahpeton	30	0	30	23	10	0	37
Total	189	17	40	22	6	1	14

Table 14. Preplant incorporated or preemergence herbicides used in sugarbeet in 2018.

Location	Responses	PPI or PRE Herbicides Applied					
		S-metolachlor	ethofumesate	Ro-Neet SB	S-metolachor +ethofumesate	Other	None
		---% of responses---					
Fargo	40	50	8	0	2	5	35
Grafton	39	0	0	3	7	3	87
Grand Forks	82	6	0	0	0	1	93
Wahpeton	28	50	11	0	28	0	11
Willmar	82	36	22	1	6	12	23
Total	271	25	9	<1	6	5	54

Table 15. Satisfaction in weed control from preplant incorporated and preemergence herbicides in 2018.

Location	Responses	PPI or PRE Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		---% of responses---					
Fargo	37	16	30	27	0	0	27
Grafton	40	2	5	8	0	2	83
Grand Forks	84	3	10	0	0	2	85
Wahpeton	31	3	70	10	7	3	7
Willmar	81	7	43	24	6	0	20
Total	273	6	29	13	3	1	48

Table 16. Soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2018.

Location	Responses	Lay-by Herbicides Applied				
		S-metolachlor	Outlook	Warrant	Other	None
		---% of responses---				
Fargo	62	64	13	3	2	18
Grafton	52	4	2	0	0	94
Grand Forks	94	7	12	1	1	79
Wahpeton	41	68	27	0	0	5
Willmar	123	6	69	20	0	5
Total	372	23	31	8	<1	38

Table 17. Satisfaction of weed control from soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2018.

Location	Responses	Lay-by Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		---% of responses---					
Fargo	36	8	53	14	3	0	22
Grafton	39	5	0	5	0	0	90
Grand Forks	79	9	6	1	0	3	81
Wahpeton	30	3	77	10	7	0	3
Willmar	79	5	61	29	3	1	1
Total	263	7	36	13	2	1	41

Table 18. Mechanical weed control methods used in sugarbeet in 2018.

Location	Responses	Rotary Hoe	Row-Cultivation	Hand-Weeded	Other	None
		-------------------------------------% of responses-----------------------------------				
Fargo	44	0	18	46	0	36
Grafton	44	2	9	25	2	62
Grand Forks	92	1	3	29	6	61
Wahpeton	30	0	3	47	3	47
Willmar	102	1	29	49	2	19
Total	312	1	15	39	3	42

Table 19. Percent of sugarbeet acres row-crop cultivated in 2018.

		% Acres Row-Cultivated				
Location	Responses	0	< 10	10-50	51-100	>100
		-----------------------------------% of responses------------------------------				
Fargo	39	77	13	10	0	0
Grafton	41	85	12	3	0	0
Grand Forks	84	80	18	0	0	2
Wahpeton	30	74	20	3	0	3
Willmar	81	51	12	9	13	15
Total	275	71	15	5	4	5

Table 20. Percent of sugarbeet acres hand-weeded in 2018.

		% Acres Hand-Weeded				
Location	Responses	0	< 10	10-50	51-100	>100
		------------------------------------% of responses------------------------------				
Fargo	39	33	54	13	0	0
Grafton	42	62	31	7	0	0
Grand Forks	85	56	36	4	4	0
Wahpeton	30	60	20	17	3	0
Willmar	82	28	23	32	4	13
Total	278	46	32	15	3	4

SMBSC Cercospora Leaf Spot Fungicide 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 best management practices that include an appropriately timed fungicide program that utilizes multiple modes of action.

Objective: High levels of inoculum, increasing fungicide resistance, 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 programs.

Materials and Methods: Separate trials were conducted as randomized complete block with four replications at the same site near Bird Island, MN. These trials evaluated fungicides in a program setting, but also for individual efficacy, the Program and Fungicide Screening trials respectively. This site was planted on May 15th using Crystal M380 with 3gpa of 6-24-6 starter fertilizer. Dual Magnum was applied preemergence and as a layby application with Roundup Powermax to keep the site weed free. The site was inoculated with 2.6 lbs/acre of pulverized leaves from the previous year that were infected with CLS. The inoculum was spread evenly across the site with a Gandy Orbit-Air applicator on July 8th. Five fungicide applications were made in the Fungicide Screening Trial and six applications were made in the Program Trial beginning July 15th and continuing on a ten to twelve-day spray interval. The Fungicide Screening did not receive the sixth application as that portion of the trial site was too wet to support equipment. Applications were made using a custom fabricated tractor sprayer traveling 3.6mph with a spray volume of 20gpa, 60psi, and 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) (1-9) scale with one being disease free and nine being completely necrotic. The center two rows of each six row plot were harvested on October 19th using a six row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the tare lab. The data was analyzed for significance using SAS version 9.4.

Program Trial Results: Few significant differences were found in the yield and quality parameters of the Program Trial (Table 1). The untreated check had significantly lower yield and quality parameters compared to all of the other treatments. The rest of the treatments were very similar and had excellent yield and quality parameters considering the shortened growing season. 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. Although there were not many differences in the Program Trial between treatments with different adjuvants, there was a monetary difference in the return on these treatments (Table 3).

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	14.7 a	22.9 a	12.4 a	248.3 a	5692.6 a	91.4 NS
Standard Program	16.6 b	32.2 bc	14.3 bc	286.0 bc	9218.9 b	92.1 NS
Standard Inverse Program	17.1 bcd	31.3 bc	14.7 bcd	294.3 bcd	9213.8 b	92.0 NS
Standard No Tank-Mix Program	16.6 b	31.7 bc	14.3 bc	285.9 bc	9062.1 b	92.0 NS
Standard Inverse Program w/ Masterlock	16.9 bcd	32.6 bc	14.6 bcd	292.3 bcd	9520.4 b	92.6 NS
EBDC Program w/ Reguard, Diligence, and Ndemand (ace)	16.8 bcd	32.5 bc	14.7 bcd	293.0 bcd	9529.4 b	92.8 NS
EBDC Program w/ Masterlock	17.2 d	32.4 bc	14.8 cd	296.7 cd	9601.3 b	92.0 NS
EBDC Program w/ Masterlock and Transfix	16.9 bcd	31.3 bc	14.7 bcd	293.3 bcd	9193.4 b	92.4 NS
EBDC Program w/ Reguard and Diligence	16.9 bcd	31.1 bc	14.6 bcd	292.5 bcd	9091.1 b	92.4 NS
EBDC Program	16.8 bcd	32.8 c	14.6 bcd	291.5 bcd	9562.6 b	92.4 NS
EBDC Program w/ Reguard, Diligence, Ndemand (ace), Boron (ac), and Priaxor (e)	16.8 bcd	32.9 c	14.7 bcd	293.6 bcd	9668.7 b	93.2 NS
EBDC Program w/ Justified + Cohere	17.1 bcd	30.4 b	14.9 d	297.8 d	9061.5 b	92.8 NS
EBDC Program w/ Cerium Elite	17.1 bcd	31.7 bc	14.7 bcd	294.5 bcd	9327.7 b	91.9 NS
EBDC Program w/ Franchise	17.0 bcd	31.4 bc	14.7 bcd	293.4 bcd	9200.4 b	92.1 NS
Standard Inverse Program w/ Triazole Mix First	16.9 bcd	32.8 c	14.6 bcd	291.3 bcd	9568.6 b	92.3 NS
EBDC Program w/ Beetboost (ac)	16.7 bc	32.3 bc	14.2 b	284.5 b	9187.3 b	91.4 NS
Standard Inverse Program Main fb Partners	17.2 d	31.4 bc	15.0 d	299.6 d	9413.5 b	92.7 NS
Standard Inverse Program w/ Provysol (ace)	17.1 bcd	32.4 bc	14.8 cd	296.5 cd	9668.2 b	92.4 NS
Standard Inverse Program w/ Brixen (a)	16.9 bcd	32.3 bc	14.6 bcd	292.2 bcd	9426.2 b	92.2 NS
EBDC Program w/ Liberate	17.2 cd	31.6 bc	14.9 d	298.9 d	9451.4 b	92.7 NS
Mean	16.8	31.5	14.5	290.8	9176.8	92.3
CV%	2.2	5.0	2.8	2.8	5.1	1.1
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.5923

Table 1: Yield parameter results for the 2019 Program Trial. Values with different letters are significantly different (*P*= 0.05). Table 6 contains a full description of each treatment. Letters that follow products indicate when the product was included in the application.

Treatment	CLS Rating[1]	ESA[2]	Cost[3]	ROI[4]
EBDC Program w/ Reguard, Diligence, and Ndemand (ace)	3.6	9529.4	$173.71	$ (63.62)
EBDC Program w/ Masterlock	3.4	9601.3	$121.45	$ 16.67
EBDC Program w/ Masterlock and Transfix	3.9	9193.4	$131.35	$ (68.96)
EBDC Program w/ Reguard and Diligence	3.3	9091.1	$150.31	$(104.96)
EBDC Program	3.6	9562.6	$108.83	$ -
EBDC Program w/ Reguard, Diligence, Ndemand (ace), Boron (ac), and Priaxor (e)	3.3	9668.7	$210.92	$ (76.36)
EBDC Program w/ Cohere and Justified	3.5	9061.5	$125.35	$ (63.43)
EBDC Program w/ Cerium Elite	3.9	9327.7	$121.03	$ (32.36)
EBDC Program w/ Franchise	3.8	9200.4	$193.09	$(128.37)
EBDC Program w/ Liberate	4.4	9451.4	$132.55	$ (5.33)

Table 3: Comparison of return on investment for Program treatments with different adjuvants.
[1] The CLS rating in this table is the last rating of the season on September 26th. [2] ESA is extractable sugar per acre. [3] This cost only represents the cost of the products used in the fungicide program. [4] ROI or return on investment is the net revenue for each treatment (gross revenue - total product cost) compared to the same program with no adjuvant.

Treatment	8-Aug	15-Aug	22-Aug	30-Aug	6-Sep	13-Sep	20-Sep	26-Sep
Check	2.7 a	5.0 a	5.8 a	7.1 a	8.9 a	9.0 a	9.0 a	9.0 a
Standard Program	1.0 d	1.5 c	2.0 cd	2.2 gh	2.2 efgh	2.9 efg	3.5 efghi	4.1 fgh
Standard Inverse Program	1.1 bcd	1.5 c	1.9 cde	2.5 defg	2.5 def	3.3 cde	3.9 cde	4.8 cde
Standard No Tank-Mix Program	1.2 b	1.9 b	2.6 b	3.7 b	3.5 b	4.9 b	6.0 b	7.0 b
Standard Inverse Program w/ Masterlock	1.0 d	1.5 c	1.9 cde	2.5 defg	2.2 fghi	3.1 ef	3.9 def	4.6 cdef
EBDC Program w/ Reguard, Diligence, and Ndemand (ace)	1.0 d	1.4 c	1.7 de	2.1 h	1.9 ghij	2.4 ij	3.3 ghijk	3.6 ij
EBDC Program w/ Masterlock	1.1 bcd	1.4 c	1.8 de	2.2 gh	2.0 ghij	2.3 j	3.0 kj	3.4 j
EBDC Program w/ Masterlock and Transfix	1.1 bcd	1.6 bc	1.9 cde	2.3 gh	2.0 ghij	2.6 ghij	3.4 fghij	3.9 ghi
EBDC Program w/ Reguard and Diligence	1.1 bcd	1.4 c	1.8 de	2.2 gh	1.9 hij	2.4 hij	3.1 ijk	3.3 j
EBDC Program	1.1 bcd	1.4 c	1.7 de	2.3 fgh	2.0 ghij	2.3 j	3.3 hijk	3.6 hij
EBDC Program w/ Reguard, Diligence, Ndemand (ace), Boron (ac), and Priaxor (e)	1.0 d	1.6 bc	1.7 e	2.3 fgh	1.7 j	2.4 ij	2.8 k	3.3 j
EBDC Program w/ Justified + Cohere	1.2 bcd	1.5 c	1.7 de	2.1 h	2.1 ghi	2.5 hij	3.2 ijk	3.5 ij
EBDC Program w/ Cerium Elite	1.2 bc	1.5 c	1.8 de	2.1 h	2.0 ghij	2.4 hij	3.3 hijk	3.9 ghij
EBDC Program w/ Franchise	1.1 bcd	1.4 c	1.8 de	2.4 efgh	2.3 efg	2.8 fghi	3.4 fghij	3.8 ghij
Standard Inverse Program w/ Triazole Mix First	1.0 cd	1.4 c	1.8 de	2.5 defg	2.5 cde	3.1 def	3.8 defg	4.7 cdef
EBDC Program w/ Beetboost (ac)	1.1 bcd	1.4 c	1.8 de	2.3 gh	1.9 ij	2.3 j	3.1 ijk	3.4 ij
Standard Inverse Program Main fb Partners	1.1 bcd	1.7 bc	2.2 c	2.8 cd	2.8 c	3.6 c	4.2 cd	5.0 cd
Standard Inverse Program w/ Provysol (ace)	1.1 bcd	1.4 c	2.0 cde	2.7 cde	2.6 cd	3.6 c	4.4 c	5.1 c
Standard Inverse Program w/ Brixen (a)	1.0 d	1.5 c	1.9 cde	2.9 c	2.6 cde	3.5 cd	4.1 cd	4.6 def
EBDC Program w/ Liberate	1.0 d	1.6 bc	1.9 cde	2.6 cdef	2.1 fghi	2.8 fgh	3.7 defgh	4.4 efg
Mean	1.1	1.7	2.1	2.7	2.6	3.2	3.9	4.5
CV%	10.2	12.9	10.7	9.8	9.5	9.1	9.1	8.7
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.17	0.30	0.31	0.37	0.34	0.41	0.50	0.55

Table 2: Visual foliar ratings for the 2019 Program Trial using the KWS (1-9) rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Table 6 contains a full description of each treatment. Letters that follow product names indicate when the product was included in the application.

Fungicide Screening Trial Results: It is not recommended by SMBSC or industry partners to apply the same fungicide back-to-back. This trial was done for the sole purpose of comparing individual fungicide effectiveness. Several significant differences were found in the yield and quality parameters of the Fungicide Screening Trial (Table 4). The untreated check had substantially lower yield and quality parameters than any of the other treatments. The treatments with only one mode-of-action and the Proline + Badge treatment had either significantly or numerically lower extractable sugar per acre (ESA) than all other treatments with two modes-of-action. Manzate Prostick and Proline applied as a tank-mix treatment had significantly higher ESA than those products applied alone. The difference in the foliar ratings correlated well with the differences seen in the yield parameters (Table 5). The untreated check had the highest foliar rating followed by treatments with only one mode-of-action, Proline + Badge, and Proline + Oxidate 2.0. Most of the other treatments with two modes-of-action were very similar with the exception of Proline + Manzate Prostick and Propulse + Manzate Prostick having significantly lower ratings.

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 2019 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, SDHI, or biological products did not appear to add any significant benefit to disease control. However, these conclusions are only based on one year of testing and should not be used exclusively for making recommendations in 2020.

Treatment	Percent Sugar	Tons PerAcre	Percent Extractable Sugar	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity
Check	13.9 a	23.7 a	11.5 a	229.0 a	5418.5 a	89.9 NS
Manzate Prostick	16.0 b	29.2 bcd	13.7 bc	273.0 bc	7968.5 bcde	91.7 NS
Proline	16.1 bc	29.1 bcd	13.8 bcd	275.8 bcd	7869.7 bcd	91.9 NS
Proline + Badge SC	16.3 bcd	27.1 b	14.0 bcd	279.7 bcd	7281.3 b	92.2 NS
Proline + Manzate Prostick	17.1 ef	31.6 d	14.7 de	293.5 de	9308.8 gh	92.1 NS
Propulse + Manzate Prostick	17.6 f	31.5 d	15.1 e	302.0 e	9837.5 h	91.9 NS
Lucento + Manzate Prostick	16.3 bcd	30.2 cd	14.1 bcde	282.3 bcd	8647.3 cdefg	92.4 NS
Topguard + Manzate Prostick	16.7 cde	30.2 cd	14.3 bcde	286.5 bcde	8661.5 defg	92.0 NS
Provysol + Manzate Prostick	16.2 bcd	31.4 d	14.0 bcd	279.3 bcd	8762.0 defg	92.2 NS
Supertin + Manzate Prostick	16.1 bcd	29.6 bcd	13.8 bcd	275.5 bcd	8160.3 bcdef	91.8 NS
Proline + Oxidate 2.0	16.4 bcd	30.4 cd	14.1 bcd	281.3 bcd	8558.8 cdefg	91.9 NS
Proline + Manzate Prostick (bde) or Lifegard (ac)	16.6 bcde	30.8 d	14.2 bcde	283.8 bcde	8878.7 efgh	91.8 NS
Proline + Manzate Prostick (bde) or Double Nickel LC (ac)	16.5 bcde	30.7 cd	14.2 bcde	284.0 bcde	8710.8 defg	92.1 NS
Mean	16.2	29.7	13.9	278.3	8291.6	91.9
CV%	2.6	6.2	4.7	4.6	7.1	2.1
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	0.9711

Table 4: Yield parameter results for the 2019 Fungicide Screening Trial. Values with different letters are significantly different (*P*= 0.05). Letters that follow products indicate when the product was included in the application. If no letters follow a product than that product was included in every application. It is not recommended by SMBSC or industry partners to apply the same fungicide back-to-back. This trial was done for the sole purpose of comparing individual fungicide effectiveness.

Treatment	8-Aug	15-Aug	22-Aug	30-Aug	6-Sep	13-Sep	20-Sep	26-Sep
Check	3.1 a	5.5 a	6.0 a	7.0 a	8.9 a	9.0 a	9.0 a	9.0 a
Manzate Prostick	1.4 bc	2.4 bc	2.6 bc	3.8 bc	4.1 bv	5.6 b	7.2 b	8.0 bc
Proline	1.3 cd	2.2 cd	2.4 bcd	3.5 cde	3.7 cde	5.4 b	7.0 b	8.1 b
Proline + Badge SC	1.6 b	2.7 b	2.7 b	4.0 b	4.2 b	5.4 b	6.9 bc	7.8 bc
Proline + Manzate Prostick	1.2 cde	1.6 fghi	1.8 ef	2.4 f	2.3 hi	2.9 d	3.9 h	4.8 g
Propulse + Manzate Prostick	1.1 e	1.5 hi	1.7 ef	2.6 f	2.3 hi	3.0 d	3.8 h	5.2 g
Lucento + Manzate Prostick	1.2 cde	1.6 fghi	2.0 edf	3.3 de	3.2 efg	4.0 c	5.4 g	6.5 f
Topguard + Manzate Prostick	1.2 cde	2.2 bcd	2.2 d	3.6 bcd	3.5 def	4.3 c	5.5 fg	6.9 def
Provysol + Manzate Prostick	1.2 cde	1.9 defgh	2.0 def	3.3 de	3.4 def	4.0 c	5.6 fg	6.6 ef
Supertin + Manzate Prostick	1.2 cde	2.0 cdef	2.1 de	3.3 de	2.8 g	4.0 c	5.5 fg	6.4 f
Proline + Oxidate 2.0	1.2 cde	2.1 cde	2.3 bcd	3.5 cde	3.4 def	5.2 b	6.7 bcd	7.6 bcd
Proline + Manzate Prostick (bde) or Lifegard (ac)	1.2 cde	1.8 efghi	2.0 def	3.1 e	2.8 gh	4.1 c	5.7 fg	6.4 f
Proline + Manzate Prostick (bde) or Double Nickel LC (ac)	1.2 cde	2.0 cdefg	2.1 de	3.1 e	3.1 fg	4.1 c	6.0 defg	6.8 ef
Mean	1.3	2.1	2.3	3.4	3.4	4.5	5.8	6.8
CV%	14.4	14.3	11.7	9.4	10.5	9.0	9.2	8.0
Pr>F	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
lsd (0.05)	0.27	0.43	0.39	0.45	0.51	0.57	0.76	0.76

Table 5: Visual foliar ratings for the 2019 Fungicide Screening Trial using the KWS (1-9) rating system with 1 being disease free and 9 being completely necrotic. Ratings with different letters are significantly different. Letters that follow products indicate when the product was included in the application. If no letters follow a product than that product was included in every application.

2019 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
	Induce	0.125 %	E
4) Standard No Tank-Mix Program	SuperTin	8 oz	ACE
	Inspire XT	7 oz	B
	Proline	5.7 oz	F
	Induce	0.125 %	F
	Eminent VP	13 oz	D
5) Standard Inverse Program w/ Masterlock	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
6) EBDC Program w/ Reguard, Diligence, and Ndemand	Inspire XT	7 oz	A
	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
7) EBDC Program w/ Masterlock	Inspire XT	7 oz	A
	Manzate Prostick	2 lbs	ABCDEF
	Masterlock	6.4 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
8) EBDC Program w/ Masterlock and Transfix	Inspire XT	7 oz	A
	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
9) EBDC Program w/ Reguard and Diligence	Inspire XT	7 oz	A
	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
10) 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

Table 6: 2019 Program Trial protocol. The application code indicates when the product was applied in the six program treatments.

2019 Program Trial Cont.		Rate/Acre	Application Code
11) EBDC Program w/ Reguard, Diligence, Ndemand, Boron, and Priaxor	Inspire XT	7 oz	A
	Manzate Prostick	2 lbs	ABCDEF
	Reguard	12 oz	ABCDEF
	Diligence	1.5 oz	ABCDEF
	N-Demand	1 gal	ACE
	Boron	20 oz	AC
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Priaxor	8 oz	E
	Proline	5.7 oz	E
12) EBDC Program w/ Justified and Cohere	Inspire XT	7 oz	A
	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 w/ Cerium Elite	Inspire XT	7 oz	A
	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 w/ Franchise	Inspire XT	7 oz	A
	Manzate Prostick	2 lbs	ABCDEF
	Franchise	12.8 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
15) EBDC Program w/ Triazole Mix First	Inspire XT	7 oz	A
	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Manzate Prostick	2 lbs	ABDE
	Topguard	14 oz	A
	Proline	5.7 oz	E
	Masterlock	6.4 oz	ABCDEF
16) EBDC Program w/ BeetBoost	Inspire XT	7 oz	A
	Manzate Prostick	2 lbs	ABCDEF
	Reguard	12 oz	ABCDEF
	Diligence	1.5 oz	ABCDEF
	BeetBoost	1 qt	AC
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
17) EBDC Program Main fb partners	Inspire XT	7 oz	A
	SuperTin	8 oz	ACE
	Masterlock	6.4 oz	ABCDEF
	Badge SC	32 oz	BDF
	Manzate Prostick	2 lbs	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E
18) EBDC Program Provysol Substitution	Provysol	5 oz	ACE
	Badge SC	32 oz	CF
	SuperTin	8 oz	BDF
	Manzate Prostick	2 lbs	ABDE
	Masterlock	6.4 oz	ABCDEF
19) Manzate Program Brixen Substitution	Brixen	21 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
20) EBDC Program w/ Liberate	Inspire XT	7 oz	A
	Manzate Prostick	2 lbs	ABCDEF
	Liberate	12.8 oz	ABCDEF
	SuperTin	8 oz	BDF
	Eminent VP	13 oz	C
	Proline	5.7 oz	E

Fungicide Application Technology Wind Tunnel Testing

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Introduction: Cercospora Leaf Spot (CLS) is currently 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. Best management practices that improve the efficacy or longevity of current fungicides would be valuable to the overall integrated pest management system. Protectant fungicides stay on the surface of the leaf and are only effective with good coverage. Rain and poor spray coverage can hinder the ability of these protectant fungicides to work adequately. Nozzle selection, pressure, and adjuvants may all play a part in the solution to improve spray coverage and improve retention of the spray solution on the beet leaves.

Objective: To test the impact of nozzle selection, pressure, and adjuvants on the droplet spectrum of a spray solution SMBSC collaborated with Dr. Greg Kruger, Jeff Golus, and Barbara Vukoja at the University of Nebraska – West Central Research and Extension Center. In no way should anything in this report be considered an endorsement of any product on behalf of the University of Nebraska or the researchers involved in this work.

Materials and Methods: A Sympatec Helos Vario KR particle size analyzer in a low speed (15 mph air flow) wind tunnel was used to analyze different combinations of nozzles, pressures, and adjuvants with different spray solutions. The first series of tests were run using a constant pressure of 60psi across all nozzle/solution combinations (Table 2). The second series of tests were run with three different pressures across each nozzle/solution combination (Table 3). The data presented in these two tables is a summary of the data generated from the wind tunnel.

Results: The results of the wind tunnel tests are based on the key assumptions made about the optimal droplet size needed for the most effective coverage and disease control for protectant fungicides (Table 1).

Droplet size in microns	Assumption
< 150	Lost as driftable fines.
150 – 300	Desired droplet size.
300 – 410	Acceptable droplet size.
410– 500	Not effective coverage.
> 500	Risk of run-off, lost.

Table 1: Key assumptions made about droplet size and effective coverage.

The following bullet points are overarching observations made from Table 3 concerning pressure.

- As the pressure increased, so did the percentage of spray volume below 150 microns. This was true across all nozzles and spray solutions.
- As the pressure increased from 40psi to 60psi, the percentage of spray volume in the optimal range increased. This was true across all nozzles and spray solutions.
- As the pressure increased the percentage of spray volume above 410 microns decreased. This is true across all nozzles and spray solutions.
- On average, over 21% of the spray solution was at risk of evaporation or drift when spraying at 90psi. This compares to an average of 14% when spraying at 60psi.

The following bullet points are overarching observations made from Tables 2 and 3 concerning nozzle selection.

- Using a hollow cone or a flat fan nozzle increased the percentage of spray volume in the optimal range by over 10% compared to a Turbo Teejet nozzle.
- The Turbo Teejet nozzle had the most variability in droplet size between spray solutions.
- Fungicide formulation may also impact the spray droplet spectrum. The combination of Supertin and Manzate Prostick applied with a Turbo Teejet nozzle had a concerning percentage of spray droplets that would be considered ineffective at 90psi (42%).

The following bullet points are overarching observations made from Tables 2 and 3 concerning the addition of adjuvants to the spray solution.

- Adding Diligence-EA or Masterlock to a spray solution with a Turbo Teejet nozzle increased the percentage of spray volume potentially lost to drift or evaporation.
- The addition of Transfix or Reguard to a spray solution did not impact the spray droplet spectrum.
- Masterlock increased the percentage of spray volume in the optimal range more than Diligence-EA.

Discussion: Using high spray pressures of 90psi resulted in a potential loss to drift of more than 21% of the spray solution. If 20gpa was being applied more than 4 gallons of that solution would not be reaching the intended target. However, low pressures such as 40psi had a large percentage of the spray volume larger than 410microns. This is also unacceptable as these droplets will not provide effective coverage or control. A moderate pressure of 60psi appears to reduce the percentage of spray volume lost to drift and reduce the percentage of large ineffective droplets.

The variability of the Turbo Teejet nozzle in these tests suggests that the reliability of this nozzle to provide consistent coverage across a range of factors would be less than other nozzles tested. The addition of a deposition aid (used to reduce drift) actually increased the percent of spray volume prone to drift when using a Turbo Teejet nozzle. Based on these results the use of a Turbo Teejet nozzle for fungicide applications is not recommended.

The use of Masterlock or Diligence-EA generally had a positive impact reducing the percentage of spray volume below 150 microns and reducing the percentage of spray volume larger than 410 microns. Overall, Masterlock improved the percentage of spray volume in the optimal range more than Diligence-EA. These results suggest that the use of adjuvants can have a positive impact on the droplet spectrum, but that care should be taken when choosing an adjuvant for fungicide applications.

Conclusion: Under ideal conditions (no wind or evaporation) smaller droplets provide the best coverage. However, most fungicide applications are not made under ideal conditions. Even moderate winds between 5 to 10 mph can cause most droplets under 150 microns to be lost to drift or evaporation. Nozzle, pressure, and adjuvant selection can all play a role in improving overall coverage of the canopy and ultimately improving disease control. The example given in Table 4 illustrates how changes to these parameters in a sprayer setup can significantly improve the percentage of spray solution reaching the beet canopy.

Sprayer Setup			**<150**	**150-410**	**>410**	**Difference in Optimal Range**
Nozzle	**Pressure**	**Adjuvant**				
Turbo Teejet 11005	90psi	None	16.7	57.8	25.5	0.0%
Flat Fan XR11005	90psi	None	24.4	67.6	8.1	9.8%
Flat Fan XR11005	60psi	None	18.2	68.8	13.0	1.2%
Flat Fan XR11005	60psi	Masterlock	12.5	76.0	11.6	7.2%
						Total: 18.2%

Table 4: If a grower started with the sprayer setup in the first row of the table and made the following adjustments in red down the table the overall percentage of spray solution effectively reaching the target would be significantly increased.

Nebraska Wind Tunnel Trial 1	**< 150**	**150 - 410**	**> 410**
Turbo Teejet - TT11005			
Inspire XT + Manzate Prostick	13.3	67.4	19.3
Inspire XT + Manzate Prostick + Diligence + Reguard	12.2	64.6	23.2
Inspire XT + Manzate Prostick + Diligence + Reguard + Ndemand	12.3	68.4	19.3
Inspire XT + Manzate Prostick + Masterlock	17.1	69.3	13.6
Inspire XT + Manzate Prostick + Masterlock + Transfix	16.7	70.0	13.2
Supertin + Manzate Prostick	10.0	53.1	36.9
Supertin + Manzate Prostick + Diligence + Reguard	10.7	57.9	31.5
Supertin + Manzate Prostick + Masterlock	16.9	69.8	13.3
Supertin + Manzate Prostick + Masterlock + Transfix	16.0	70.4	13.6
Supertin + Manzate Prostick + Liberate	15.6	67.6	16.9
Hollow Cone - TXR80049			
Inspire XT + Manzate Prostick	9.7	76.9	13.3
Inspire XT + Manzate Prostick + Diligence + Reguard	13.3	74.4	12.3
Inspire XT + Manzate Prostick + Diligence + Reguard + Ndemand	10.3	76.4	13.4
Inspire XT + Manzate Prostick + Masterlock	12.0	78.4	9.6
Inspire XT + Manzate Prostick + Masterlock + Transfix	12.3	77.6	10.2
Supertin + Manzate Prostick	15.7	70.7	13.6
Supertin + Manzate Prostick + Diligence + Reguard	12.9	72.1	15.0
Supertin + Manzate Prostick + Masterlock	12.1	77.5	10.4
Supertin + Manzate Prostick + Masterlock + Transfix	10.9	75.4	13.7
Supertin + Manzate Prostick + Liberate	12.6	76.5	10.9
Flat Fan - XR11005			
Inspire XT + Manzate Prostick	12.1	74.2	13.7
Inspire XT + Manzate Prostick + Diligence + Reguard	15.4	75.0	9.6
Inspire XT + Manzate Prostick + Diligence + Reguard + Ndemand	12.8	76.0	11.2
Inspire XT + Manzate Prostick + Masterlock	12.5	77.2	10.3
Inspire XT + Manzate Prostick + Masterlock + Transfix	12.7	76.9	10.5
Supertin + Manzate Prostick	17.9	69.4	12.7
Supertin + Manzate Prostick + Diligence + Reguard	15.3	71.8	13.0
Supertin + Manzate Prostick + Masterlock	13.2	77.0	9.9
Supertin + Manzate Prostick + Masterlock + Transfix	12.7	76.9	10.5
Supertin + Manzate Prostick + Liberate	15.0	76.3	8.7
CV%	1.82	0.66	2.71
LSD (0.05)	0.37	0.75	0.77
Pr>F	<.0001	<.0001	<.0001

Table 2: Droplet spectrum results from the first series of testing. All combinations for this test were done using 60psi. The numbers in this table are equal to the percent of spray volume for the given droplet micron size range.

Nebraska Wind Tunnel Trial 2	**PSI**	**< 150**	**150 - 410**	**> 410**
Turbo Teejet 11005				
Supertin + Manzate Prostick	40	5.6	44.2	50.2
Supertin + Manzate Prostick	60	10.1	52.1	37.8
Supertin + Manzate Prostick	90	16.7	57.8	25.5
Supertin + Manzate Prostick + Diligence-EA + Reguard	40	6.0	50.4	43.6
Supertin + Manzate Prostick + Diligence-EA + Reguard	60	11.2	59.0	29.8
Supertin + Manzate Prostick + Diligence-EA + Reguard	90	18.7	62.9	18.4
Supertin + Manzate Prostick + Masterlock + Reguard	40	8.9	62.7	28.4
Supertin + Manzate Prostick + Masterlock + Reguard	60	15.5	68.4	16.1
Supertin + Manzate Prostick + Masterlock + Reguard	90	25.1	68.6	6.3
Supertin + Manzate Prostick + Masterlock	40	9.4	63.8	26.8
Supertin + Manzate Prostick + Masterlock	60	16.4	69.4	14.2
Supertin + Manzate Prostick + Masterlock	90	26.1	67.4	6.6
Supertin + Manzate Prostick + Masterlock + Transfix	40	9.3	63.4	27.3
Supertin + Manzate Prostick + Masterlock + Transfix	60	16.0	69.0	15.0
Supertin + Manzate Prostick + Masterlock + Transfix	90	25.6	67.4	7.1
Hollow Cone 80049				
Supertin + Manzate Prostick	40	13.7	69.0	17.3
Supertin + Manzate Prostick	60	19.5	70.3	10.2
Supertin + Manzate Prostick	90	24.2	68.6	7.2
Supertin + Manzate Prostick + Diligence-EA + Reguard	40	9.7	70.2	20.1
Supertin + Manzate Prostick + Diligence-EA + Reguard	60	14.5	73.1	12.5
Supertin + Manzate Prostick + Diligence-EA + Reguard	90	22.0	72.4	5.6
Supertin + Manzate Prostick + Masterlock + Reguard	40	8.3	74.1	17.6
Supertin + Manzate Prostick + Masterlock + Reguard	60	13.2	78.1	8.7
Supertin + Manzate Prostick + Masterlock + Reguard	90	19.9	76.4	3.6
Supertin + Manzate Prostick + Masterlock	40	7.8	74.1	18.1
Supertin + Manzate Prostick + Masterlock	60	12.1	78.4	9.5
Supertin + Manzate Prostick + Masterlock	90	19.7	76.6	3.7
Supertin + Manzate Prostick + Masterlock + Transfix	40	7.5	73.5	19.0
Supertin + Manzate Prostick + Masterlock + Transfix	60	12.0	77.9	10.1
Supertin + Manzate Prostick + Masterlock + Transfix	90	19.0	76.8	4.2
Flat Fan XR11005				
Supertin + Manzate Prostick	40	13.0	68.4	18.6
Supertin + Manzate Prostick	60	18.2	68.8	13.0
Supertin + Manzate Prostick	90	24.4	67.6	8.1
Supertin + Manzate Prostick + Diligence-EA + Reguard	40	9.2	68.5	22.3
Supertin + Manzate Prostick + Diligence-EA + Reguard	60	14.7	70.8	14.6
Supertin + Manzate Prostick + Diligence-EA + Reguard	90	21.6	69.9	8.5
Supertin + Manzate Prostick + Masterlock + Reguard	40	8.6	74.2	17.2
Supertin + Manzate Prostick + Masterlock + Reguard	60	13.0	75.5	11.4
Supertin + Manzate Prostick + Masterlock + Reguard	90	19.3	74.3	6.4
Supertin + Manzate Prostick + Masterlock	40	8.3	73.0	18.7
Supertin + Manzate Prostick + Masterlock	60	12.5	76.0	11.6
Supertin + Manzate Prostick + Masterlock	90	18.6	74.9	6.4
Supertin + Manzate Prostick + Masterlock + Transfix	40	8.2	72.1	19.7
Supertin + Manzate Prostick + Masterlock + Transfix	60	11.9	76.4	11.7
Supertin + Manzate Prostick + Masterlock + Transfix	90	18.5	75.4	6.2
CV%		1.98	0.59	2.90
LSD (0.05)		0.47	0.67	0.75
Pr>F		< .0001	< .0001	< .0001

Table 3: Droplet spectrum results from the second series of testing. The numbers in this table are equal to the percent of spray volume for the given droplet micron size range.

Adjuvant Rainfastness Study

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

Introduction: Cercospora Leaf Spot (CLS) is currently the most destructive foliar disease to impact sugar beet production in the SMBSC growing area. High levels of inoculum, increasing fungicide resistance, 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. New management practices that improve the efficacy of current fungicides would be valuable to the overall integrated pest management system.

Objective: Protectant fungicides stay on the surface of the leaf and are only effective with good coverage. Rain and poor spray coverage can hinder the ability of these protectant fungicides to work adequately. Understanding the impact of rain and adjuvants on protectant fungicides may be part of the solution to improve retention of the spray solution on the beet leaves and ultimately better disease control.

Materials and Methods: To conduct this trial SMBSC collaborated with Dr. Greg Kruger, Jeff Golus, and Barbara Vukoja at the University of Nebraska – West Central Research and Extension Center. In no way should anything in this report be considered an endorsement of any product on behalf of the University of Nebraska or the researchers involved in this work. Sugar beets were planted in plastic cones 2.7 inches diameter x 14 inches tall. Soil used was ProMix General Purpose growing medium. The beets were watered as needed with 5-1-4 fertilizer injected into irrigation water at a rate of 0.2%. Spray treatments were applied with a multi-nozzle spray chamber when beets were at the 11-12 leaf stage (Figure 1). Carrier volume was 20 GPA and was achieved through a TT11004 nozzle on 20 inch spacing at 60 psi and 7.3 mph. Spray solution treatments are listed in Table 1, and four plants per treatment were used as replications. PTSA fluorescent dye was added to each spray solution at a rate of 10 g/acre to measure residual deposition on sugar beet leaves. Rainfall treatments (0, 0.5, 1, and 2 inches) were performed approximately 24 hours after spray solution application using a single nozzle spray chamber (Figure 2). An HF15 nozzle at 47 psi was used with the track carriage moving at 1.5 mph. Immediately after rainfall treatments were applied two fully exposed leaves per plant were clipped and placed individually into labelled plastic bags. Each leaf was then washed with a distilled water – isopropyl alcohol (90-10) solution to remove residual dye. A sample of this wash solution was placed in a vial and fluorescence measured with a flouremeter. Leaf area was then measured with an area meter. Two spray solutions were evaluated each day due to time constraints of applying rainfall treatments, reading fluorescence levels, and leaf area evaluations. After obtaining fluorescence and leaf area data, dye amount per area (ng per cm2) was calculated for each leaf evaluated. This data was subjected to ANOVA analysis in SAS Enterprise Guide 6.1 and mean separation conducted using Tukey's adjustment at alpha level 0.05.

Figure 1: Multi nozzle spray chamber located at the PAT lab.

Figure 2: Single nozzle spray chamber located at the PAT lab.

Treatment	Rate	Application Date
Manzate ProStick	2 lb/ac	July 29
Manzate ProStick + Masterlock	2 lb/ac + 6.4 fl oz/ac	July 30
Manzate ProStick + Masterlock + Transfix	2 lb/ac + 6.4 fl oz/ac + 4 fl oz/ac	July 30
Manzate ProStick + Reguard + Diligence	2 lb/ac + 12 fl oz/ac + 1.5 fl oz/ac	July 31
Manzate ProStick + Attach + Liberate	2 lb/ac + 1.6 fl oz/ac + 12.8 fl oz/ac	July 31
Untreated Check (Water)		July 29

Table 1: Spray solution treatments tested.

Results and Discussion: The residual deposition of the PTSA fluorescent dye was significantly decreased by all of the rainfall amounts tested (Table 2). There were no differences in residual deposition between the amounts of rainfall tested other than the no rainfall check. Any amount of rainfall reduced the residual deposition by over 95%. The reduction in residual deposition from the untreated water check to the Manzate Prostick alone with no rainfall lacks a reasonable explanation. The lack of research with ethylene bisdithiocarbamate (EBDC) products and adjuvants in sugar beets provides few references or comparisons to be made with the results of this trial. These results would indicate that none of the adjuvants tested would improve the retention of EBDC products on the sugar beet leaves. These results would also indicate that a repeat application of EBDC should be made in the event of a 0.5" rainfall or more. The threshold for a repeat application is likely lower than 0.5" based on these results and research done in other crops.

Solution	Simulated Rainfall Inches	Residual Deposition[1] ug per cm^2	
Manzate ProStick	0	3.24	B
Manzate ProStick	0.5	0.19	C
Manzate ProStick	1	0.07	C
Manzate ProStick	2	0.01	C
Manzate ProStick + Masterlock	0	4.11	AB
Manzate ProStick + Masterlock	0.5	0.48	C
Manzate ProStick + Masterlock	1	0.18	C
Manzate ProStick + Masterlock	2	0.04	C
Manzate ProStick + Masterlock + Transfix	0	3.56	AB
Manzate ProStick + Masterlock + Transfix	0.5	0.06	C
Manzate ProStick + Masterlock + Transfix	1	0.08	C
Manzate ProStick + Masterlock + Transfix	2	0.03	C
Manzate ProStick + Reguard + Diligence	0	4.26	A
Manzate ProStick + Reguard + Diligence	0.5	0.05	C
Manzate ProStick + Reguard + Diligence	1	0.06	C
Manzate ProStick + Reguard + Diligence	2	0.06	C
Manzate ProStick + Attach + Liberate	0	4.01	AB
Manzate ProStick + Attach + Liberate	0.5	0.15	C
Manzate ProStick + Attach + Liberate	1	0.07	C
Manzate ProStick + Attach + Liberate	2	0.06	C
Untreated Check (Water)	0	4.35	A
Untreated Check (Water)	0.5	0.17	C
Untreated Check (Water)	1	0.13	C
Untreated Check (Water)	2	0.04	C

Table 2: Residual deposition recovered from sugar beet leaf surface. [1]Means with the same letter are not different using Tukey's HSD at alpha = 0.05.

Cercospora Leaf Spot Adjuvant Strip Trial

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

Introduction: Cercospora Leaf Spot (CLS) is currently 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. New management practices that improve the efficacy of current fungicides would be valuable to the overall integrated pest management system.

Objective: High levels of inoculum, increasing fungicide resistance, 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. However, protectant fungicides stay on the surface of the leaf and are only effective with good coverage. Rain and poor spray coverage can hinder the ability of these protectant fungicides to work adequately. Adjuvants may be part of the solution to improve spray coverage and improve retention of the spray solution on the beet leaves.

Materials and Methods: Strip trials were conducted in 2019 to compare two adjuvant systems. Two separate trials were conducted. One strip trial was located south of Hector and the other was located near Bird Island. Each strip trial was designed as a randomized complete block with four replications. The two treatments in the strip trial compared different adjuvants with the same fungicides (Tables 1 and 2). Strips were the same width as the growers' spray boom. Four quality samples were harvested by hand from each strip prior to harvesting eight rows the entire length of the strip for yield. Each strip was harvested and the truckload was delivered to a receiving station to generate the tons per acre for each individual strip. The hand harvested samples 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 or quality parameters at either of the locations (Tables 3 and 4). There were some numerical differences at the Bird Island location, but those differences were not consistent with the Hector location. No visual differences in the amount of Cercospora Leaf Spot were observed between the treatments at either location. These results are similar to the small plot trials conducted in 2019 with adjuvants. In the 2019 growing season there appeared to be no substantial benefit to using adjuvants. Further testing needs to be done to continue to evaluate if there is a benefit to using adjuvants with fungicide applications in sugar beets.

Trt 1	Fungicide 1	Fungicide 2	Extender	Deposition	Humectancy
1 - July 11th	Supertin (8oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
2 - July 24th	Proline (5.7oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
3 - Aug 5th	AgriTin (8oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
4 - Aug 12th	Provysol (5oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
5 - Aug 27th	Supertin (8oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
6 - Sept 6th	Minerva (13oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
Trt 2					
1 - July 11th	Supertin (8oz)	Manzate Prostick (2lbs)	Reguard (12oz)	Diligence (1.5oz)	
2 - July 24th	Proline (5.7oz)	Manzate Prostick (2lbs)	Reguard (12oz)	Diligence (1.5oz)	N-Demand (1 gallon)
3 - Aug 5th	AgriTin (8oz)	Manzate Prostick (2lbs)	Reguard (12oz)	Diligence (1.5oz)	
4 - Aug 12th	Provysol (5oz)	Manzate Prostick (2lbs)	Reguard (12oz)	Diligence (1.5oz)	N-Demand (1 gallon)
5 - Aug 27th	Supertin (8oz)	Manzate Prostick (2lbs)		Masterlock (6.4oz)	
6 - Sept 6th	Minerva (13oz)	Manzate Prostick (2lbs)	Reguard (12oz)	Diligence (1.5oz)	N-Demand (1 gallon)

Table 1: Spray records for the Hector strip trial. Applications were made with an XR Teejet 11006 nozzle at 75psi with 22.5gpa. The application on August 27th was made via airplane and was applied the same across the entire field.

Trt 1	Fungicide 1	Fungicide 2	Extender	Deposition	Humectancy
1 - July 3rd	Manzate(2lbs)			Masterlock (6.4oz)	
2 - July 8th	Provysol(5oz)	Manzate(2lbs)		Masterlock (6.4oz)	
3 - July 19th	AgriTin(8oz)	Manzate Max(1.6qt)		Masterlock (6.4oz)	
4 - July 31st	Provysol(5oz)	Manzate Max(1.6qt)		Masterlock (6.4oz)	
5 - Aug 14th	AgriTin(8oz)	Manzate Max(1.6qt)		Masterlock (6.4oz)	
6 - Aug 23rd	Proline(5.7oz)	Manzate Max(1.6qt)		Masterlock (6.4oz)	
7 - Sept 6th	AgriTin(8oz)	Manzate Max(1.6qt)		Masterlock (6.4oz)	
Trt 2					
1 - July 3rd	Manzate(2lbs)			Masterlock (6.4oz)	
2 - July 8th	Provysol(5oz)	Manzate(2lbs)		Masterlock (6.4oz)	
3 - July 19th	AgriTin(8oz)	Manzate Max(1.6qt)	Reguard (12oz)	Diligence (1.5oz)	
4 - July 31st	Provysol(5oz)	Manzate Max(1.6qt)	Reguard (12oz)	Diligence (1.5oz)	N-Demand (1 gallon)
5 - Aug 14th	AgriTin(8oz)	Manzate Max(1.6qt)	Reguard (12oz)	Diligence (1.5oz)	
6 - Aug 23rd	Proline(5.7oz)	Manzate Max(1.6qt)	Reguard (12oz)	Diligence (1.5oz)	N-Demand (1 gallon)
7 - Sept 6th	AgriTin(8oz)	Manzate Max(1.6qt)	Reguard (12oz)	Diligence (1.5oz)	

Table 2: Spray records for the Bird Island strip trial. Applications were made with an XR Teejet nozzle 8005 at 75psi with 20gpa. The applications made on July 3rd and July 8th were made via airplane and was applied the same across the entire field.

Treatment	Percent Sugar	Tons/Acre	Percent Extractable Sugar	Extractable Sugar/Ton (lbs.)	Extractable Sugar/Acre (lbs.)	Percent Purity
1	16.3	20.9	14.2	283.7	5946.6	93.2
2	16.1	21.1	14.0	281.0	5937.6	93.1
Mean	16.2	21.0	14.1	282.3	5942.1	93.1
CV%	0.9	8.2	1.1	1.1	7.3	0.4
Pr>F	0.3256	0.8945	0.2931	0.2931	0.9786	0.6987
LSD (0.05)	NS	NS	NS	NS	NS	NS

Table 3: Yield parameter results for the Hector strip trial. The harvested area for each strip was 1.2 acres.

Treatment	Percent Sugar	Tons/Acre	Percent Extractable Sugar	Extractable Sugar/Ton (lbs.)	Extractable Sugar/Acre (lbs.)	Percent Purity
1	16.0	27.5	13.8	276.0	7603.8	92.3
2	16.4	28.6	14.2	283.3	8109.0	92.6
Mean	16.2	28.1	14.0	279.6	7856.4	92.5
CV%	3.0	3.9	3.1	3.1	6.9	0.8
Pr>F	0.3864	0.2563	0.3244	0.3244	0.2785	0.6617
LSD (0.05)	NS	NS	NS	NS	NS	NS

Table 4: Yield parameter results for the Bird Island strip trial. The harvested area for each strip was 0.8 acres.

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 lack of disease control in recent years has led to a build up 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 the same location of the previous year's CLS nursery. No tillage or harvest had taken place in the nursery during the previous year, but the beets were defoliated late in the fall. Since the site was previously the CLS disease nursery 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 2 used Oxidate 2.0 (peroxyacetic acid) applied through a bike sprayer at 20gpa (Image 1). The plots in Treatment 3 were tilled with a rotary tiller 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 (copper product) at a low ph applied through a bike sprayer at 20gpa. Treatment 5 used propane to burn the residue and destroy the overwintering spores (Image 2). After treatments were applied Betaseed 92RR30 was planted at a high population (109,000) without any additional tillage on May 14th. 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.

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

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

Results and Discussion: The use of tillage to bury the inoculum and heat to burn the inoculum significantly delayed the onset of CLS disease development (Table 1 and Figure 1). The Oxidate 2.0 and Badge treatments did not appear to impact the onset of disease. However, neither of these products are currently recommended for reducing CLS inoculum outside the normal growing season. Badge may have slightly increased the disease severity over the untreated check. The differences between these 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 may impact the level of disease. Further testing needs to be done to verify these results.

Image 1: Bike sprayer used to apply treatments 2 and 4.

Image 2: Propane heater used for treatment 5.

	Date of Rating								
Treatment	**7/9**	**7/11-12**	**7/14**	**7/16-17**	**7/19**	**7/22**	**7/25-26**	**7/29-30**	**Overall**
Untreated	3.1	3.6	3.6	4.6	5.0	5.6	6.6	6.3	4.8
Oxidate 2.0	2.6	3.2	3.9	4.2	4.8	5.4	6.1	6.0	4.5
Tilled	1.6	2.3	2.0	3.1	4.2	4.5	5.3	5.6	3.6
Badge	3.5	4.1	4.3	5.3	6.0	6.7	7.6	7.1	5.5
Heat	1.5	1.9	1.8	2.8	3.7	4.2	4.9	5.1	3.2
Mean	2.4	3.0	3.1	4.0	4.7	5.3	6.1	6.0	4.3
CV	29.0	24.9	16.6	12.0	15.6	13.9	11.5	13.3	13.8
Pr>F	0.0063	0.0069	<.0001	<.0001	0.0082	0.0028	0.0011	0.0385	0.0009
lsd(0.05)	1.1	1.2	0.8	0.7	1.1	1.1	1.1	1.2	0.9

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

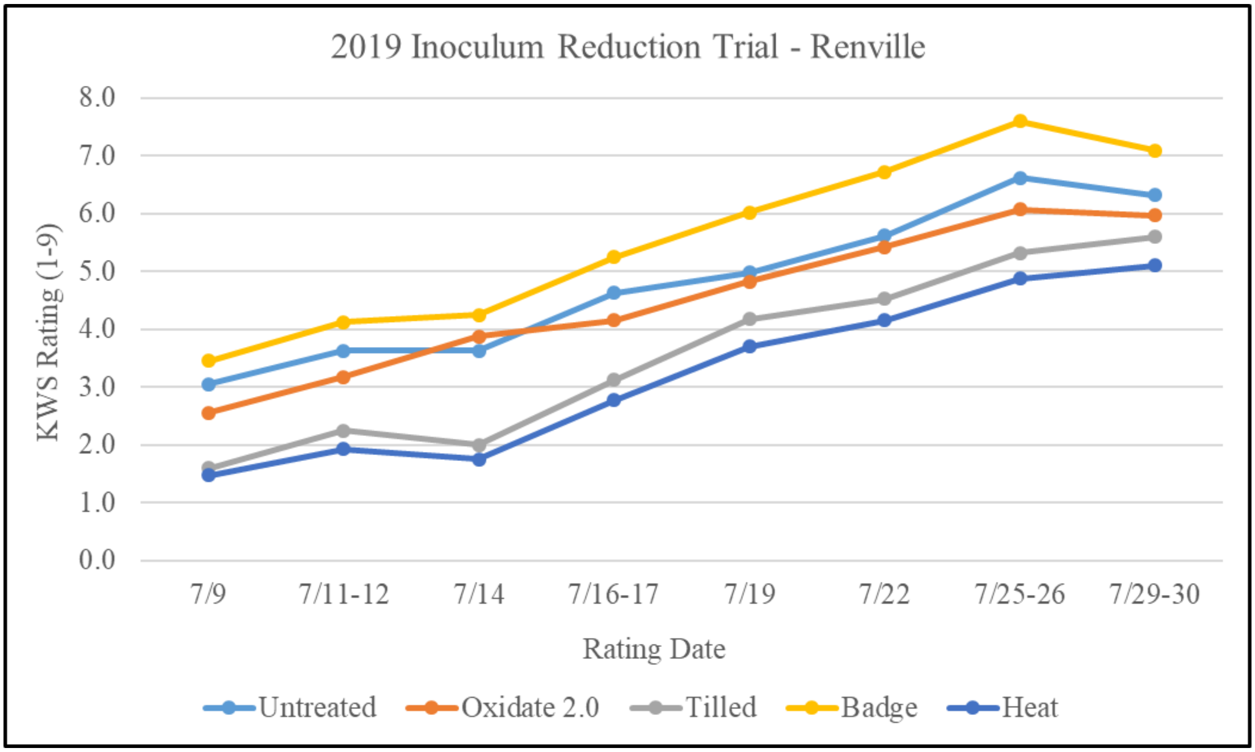

Figure 1: Foliar ratings using KWS (1-9) scale. Ratings are an average of all raters for each period.

Tachigaren Trial

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Introduction: Tachigaren is used as a seed treatment to control Aphanomyces on all of the sugar beet acres at Southern Minnesota Beet Sugar Cooperative. However, Tachigaren is known to have a negative impact on seed safety, especially with smaller seed sizes. It has been the policy of SMBSC to use a higher rate of Tachigaren which has excluded the use of mini pellets.

Objective: To evaluate the effect of different levels of Tachigaren seed treatment on sugar beet plant stand and yield in regard to seed safety and Aphanomyces control. To meet the objective, two types of trial were established. Yield trials were established at two locations with Aphanomyces potential, and a trial was established on the SMBSC Aphanomyces nursery to obtain more intensive stand count data in an environment of very high Aphanomyces disease potential.

Materials and Methods for Yield Trials: Identical yield trials were conducted as randomized complete block with six replications at the Official Variety Trial sites near Hector and Lake Lillian. This trial evaluated the effect of different levels of Tachigaren seed treatment on plant stand and yield. The Hector location was planted on May 7 and the Lake Lillian location was planted on May 6. Both trials were planted using Beta 9780. All seed treatments were applied to regular pellet sized seed. Each plot consisted of four rows that were 40ft in length. Normal practices were used to keep the trials weed and disease free throughout the growing season. The center two rows of each four row plot were harvested on October 27 at Lake Lillian and September 26 at Hector using a four row defoliator and a two row research lifter. The beets harvested from the center two rows were weighed on the harvester and a sample of those beets were used for a quality analysis at the tare lab. The data was analyzed for significance using SAS version 9.4.

Results:

Treatment	Percent Sugar	Tons/Acre	Percent Extractable Sucrose	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity	75% Stand Beets per 100ft Row	28DAP Stand Beets per 100ft Row	PreHarvest Stand Beets per 100ft Row
0 g Tach	16.6	34.3	14.3	286.6	9795.3	92.3	186.7	209.3	203.0
20 g Tach	16.9	34.3	14.7	293.2	10022.3	92.6	175.7	204.0	202.2
30 g Tach	16.8	34.5	14.5	290.2	10005.7	92.4	168.0	197.7	196.3
45 g Tach	16.6	33.6	14.1	282.9	9487.8	91.5	169.3	196.7	193.0
Mean	16.7	34.2	14.4	288.3	9829.2	92.2	174.9	201.9	198.6
CV	2.1	2.6	2.7	2.7	4.1	0.9	8.9	6.9	7.7
Pr>F	0.3944	0.2706	0.1599	0.1599	0.1241	0.1859	0.1875	0.3879	0.6344
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 1: Yield parameter results and stand counts for the yield trial at the Lake Lillian location.

Treatment	Percent Sugar	Tons/Acre	Percent Extractable Sucrose	Extractable Sugar per Ton (lbs.)	Extractable Sugar per Acre (lbs.)	Percent Purity	75% Stand Beets per 100ft Row	28DAP Stand Beets per 100ft Row	PreHarvest Stand Beets per 100ft Row
0 g Tach	15.8 b	31.3	13.7 ab	273.0 ab	8555.2	92.7	174.7	200.3	198.7
20 g Tach	15.8 b	31.2	13.6 ab	272.7 ab	8495.2	92.7	157.0	195.7	197.5
30 g Tach	15.9 b	31.3	13.8 b	276.8 b	8636.7	92.9	176.7	204.7	194.7
45 g Tach	15.6 a	28.9	13.4 a	268.2 a	7767.9	92.4	170.0	201.0	183.2
Mean	15.8	30.7	13.6	272.7	8378.4	92.7	169.6	200.4	193.5
CV	1.0	8.6	1.6	1.6	8.7	0.8	10.5	5.1	10.1
Pr>F	0.0069	0.4422	0.0279	0.0279	0.2709	0.7005	0.259	0.5221	0.5163
LSD (0.05)	0.19	NS	0.27	5.3	NS	NS	NS	NS	NS

Table 2: Yield parameter results and stand counts for the yield trial at the Hector location.

Materials and Methods for SMBSC Aphanomyces Nursery Trial: The trial was planted at the SMBSC Aphanomyces nursery in Renville on May 30. The trial was planted to Beta 9780 regular pellet sized seed with the same four Tachigaren rates as the Lake Lillian and Hector trials. Plots were two rows wide by 10’ long with six replications. Stand counts were taken beginning June 3 and continued once to twice per week until July 18. Stand counts were taken per 20’ of row and converted to sugar beets per 100’ of row for the analysis. Table 3 contain the stand counts as converted to beets per 100’ of row. Figure 1 shows a graph of the stand counts found in Table 3.

Results:

Treatment	3-Jun	10-Jun	13-Jun	17-Jun	20-Jun	24-Jun	27-Jun	3-Jul	8-Jul	18-Jul
0g Tach	217	207	203	203	197	192	188	175	171	170
20g Tach	233	228	222	220	212	208	200	188	185	183
30g Tach	258	258	259	265	263	258	250	237	232	225
45g Tach	251	261	253	253	251	248	244	222	222	215
Mean	239	238	234	235	231	226	221	205	202	198
CV	11.9	13.6	13.8	14.6	14.3	13.9	15.1	16.3	17.0	16.6
Pr>F	0.09	0.03	0.03	0.02	0.01	0.01	0.01	0.02	0.02	0.03
LSD (0.05)	N/S	39.8	39.7	42.2	40.6	38.8	41.0	41.1	42.3	40.5

Table 3: SMBSC Aphanomyces nursery stand count data. (Beets per 100’ of row)

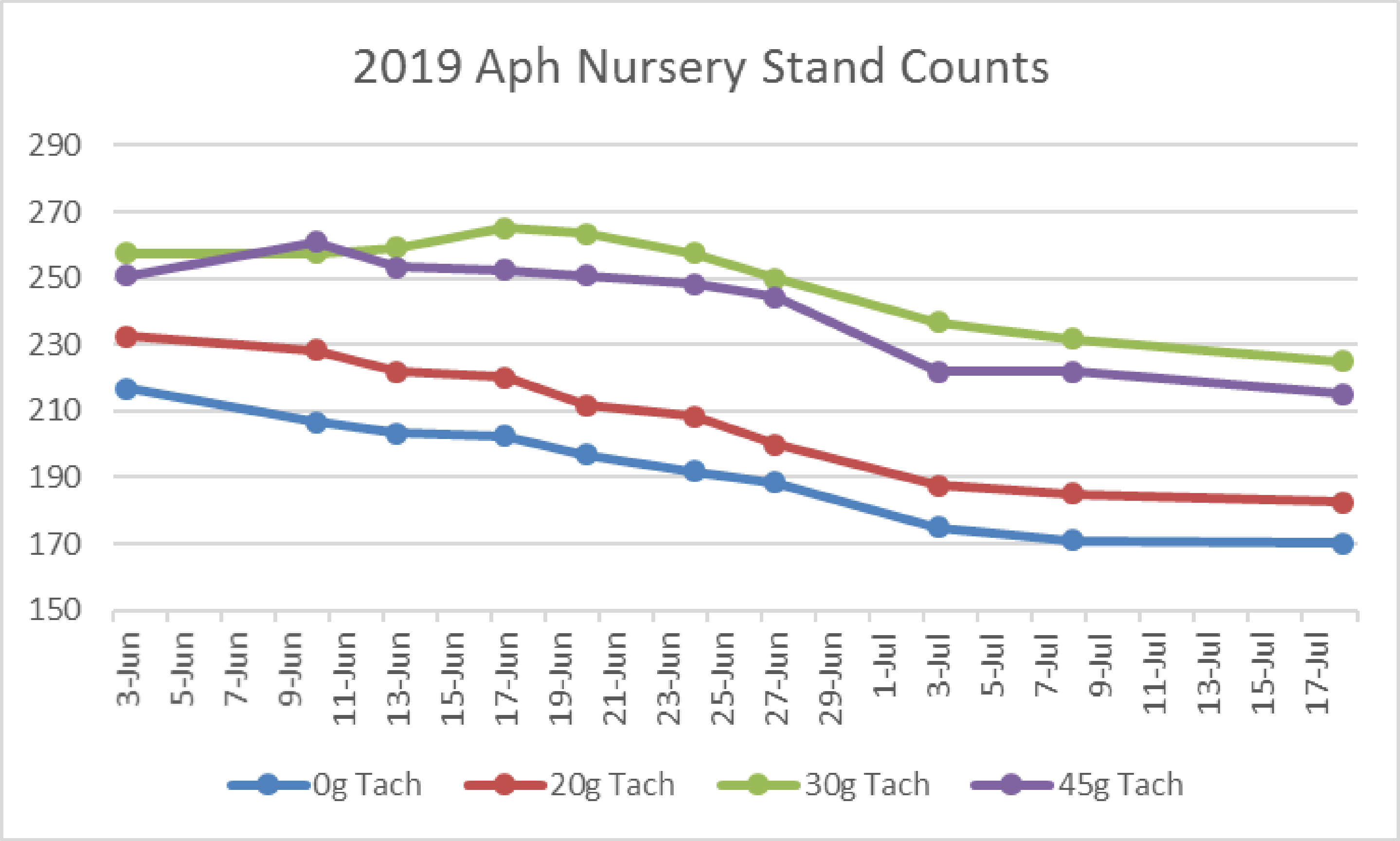

Figure 1: Stand counts per 100’ of row from SMBSC Aphanomyces Nursery.

Conclusion: Tachigaren is a seed treatment to help reduce the early season effects of Aphanomyces root rot. In the yield trials at Lake Lillian and Hector, it appears the early season Aphanomyces pressure was low. At the Lake Lillian site, there were no statistically significant differences in stand or yield. At the Hector site, there was a statistical difference in sugar, extractable sugar percent, and extractable sugar per ton. All other parameters were non-significant.

The SMBSC Aphanomyces nursery is managed for maximum early season Aphanomyces disease pressure. The trial is planted into warm and moist soils which favor disease development. In this environment, statistically significant differences in stand counts were seen. The 0 gram and 20 gram Tachigaren treatments had lower stand counts than the 30 gram and 45 gram treatments throughout the season. The Aphanomyces nursery trial area is not set up to be taken to yield, and thus we do not have data to distinguish if the stand count differences would equate to yield differences later in the season.

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

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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 (3-6). 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 (4-6).

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 R and MS variety 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 R and MS varieties were 3.9 and 4.5, respectively (7).

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 40 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 16 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 11 for control of root maggot. Sequence (glyphosate + S-metolachlor, 2.5 pt/A) was applied on June 13 and 24) 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 17 (6 leaf stage, ~4.5 weeks after planting) or June 26 (10 leaf stage, ~6 weeks after planting). Cercospora leaf spot (CLS) was controlled by Minerva Duo (16 fl oz/A) on Aug 01 and Super Tin + Topsin M (6 + 10 oz/A) on Aug 21 applied in 20 gallons water/A at 100 psi.

MDFC site. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley (40 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 31 at 4.5-inch seed spacing. Roundup PowerMax (5.5 lb product ae/gallon) tank-mixed with Dual Magnum (0.5 pt/A) was applied on Jun 05 and a tank-mix of Roundup PowerMax (5.5 lb product ae/gallon), N-tense (10 oz/A), Outlook (12 oz/A) and Stinger (4 oz/A) was applied on Jul 02. Postemergence azoxystrobin was applied in a 7-inch band on June 18 (4-leaf stage, 2.5 weeks after planting) or July 01 (8-leaf stage, 4 weeks after planting). Cercospora leaf spot was controlled by application of Super Tin + ManKocide (8 oz/A+ 2.5 lbs/A) on Jul 12, Provysol + Badge SC (5 fl. Oz/A+2 pt/A) on Jul 24, Super Tin + Manzate (8 fl oz/A+1.5 qt/A on Aug 07, and Inspire + Badge SC (2 fl oz/A+2 pt/ A) on Aug 18. All fungicides for CLS control were applied utilizing a 3pt-mounted sprayer dispersing the products in broadcast pattern at a water volume of 15 GPA with TeeJet 8002 flat fan nozzles at 80 psi.

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 = 3.9) and moderately susceptible (2-year average rating = 4.5) 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 2019 crop season based on weather stations.

	Precipitation in inches		
Month	NWROC	MDFC	SMBSC
April	1.56	0.80	-
May	1.38	2.82	4.24
June	1.39	2.65	2.40
July	3.32	6.30	4.34
August	4.72	2.50	2.46
September	6.92	5.79	5.02
October	4.15	2.73	4.01
Total	**23.44**	**23.59**	**22.44**

SMBSC site. Prior to planting, soil was infested with a mixture of four isolates of *R. solani* AG 2-2-infested whole barley (40 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 14 at 4.77-inch seed spacing. Inoculum was incorporated using the 8.5 foot cultivator followed by the drag. Weeds were controlled by application of Roundup Powermax (32 oz/A) on Jun 10 followed by Roundup Powermax (22 oz/A) Jul 16. Postemergence azoxystrobin timings were applied on June 10 (4-leaf, ~3.5 weeks after planting), or June 19 (8-leaf, ~5 weeks after planting) as 7 inch bands using 4001E nozzles at 35 psi. Cercospora leaf spot was managed by fungicide application of Dithane on Jul 03, Inspire XT + Dithane on Jul 08, SuperTin + Dithane on Jul 18, Provysol + Champ on Jul 31, Agri-Tin + Dithane on Aug 09, Minerva + Badge on Aug 21, and Super Tin + Badge on Sept 09. All fungicides for CLS control were applied in a water volume of 19.3 GPA with 11002 nozzles at 70 psi.

At NWROC and MDFC stand counts were done beginning 2 weeks after planting through 7 weeks after planting. At SMBSC stand counts were done 1.5, 4, and 6.5 weeks after planting. The trial was harvested on Sept 18 at NWROC, Oct 09 at Wahpeton and Sept 17 at Renville. Data were collected for number of harvested roots (NWROC only), yield, and quality. Twenty roots per plot also were arbitrarily selected and rated for severity of RCRR using a 0 to 7 scale (0 = healthy root, 7 = root completely rotted and foliage dead). Disease incidence was reported as the percent of rated roots with a root rot rating > 2.

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 2019 growing season was dry at the NWROC during the period of May-June resulting in lower early season disease pressure. Rainfall at the NWROC was just 1.38 in. during the month of May and 1.39 in. during the month of June (Table 2) compared to a 30-year average of 2.83 and 4.05 in., respectively. Resistant (R) and moderately susceptible (MS) varieties had similar stands from 2 to 7 weeks after planting (WAP). Untreated and Systiva treatments had higher stands from 3 to 7 WAP compared to Systiva + Quadris in-furrow and Quadris in-furrow treatments (Fig. 1). Dry conditions during early season resulted in some stand reduction (12.6% reduction at 19 days after planting compared to untreated or Systiva treated seed) in treatments with Quadris in-furrow application at this site. Stand reduction with Quadris was also observed in 2017 and 2018 (4,5). Control plants had 182 plants/100 ft. row at 7 WAP indicating very low early season disease pressure. Slight to no root rot severity and incidence were observed for both varieties at harvest. Moderately susceptible variety had significantly higher percent sucrose, less loss to molasses, and higher recoverable sucrose T^{-1} (RST) (Table 3). There were no significant differences between Quadris I-F, Systiva, Systiva + Quadris I-F or control treatment for any harvest parameters. Both 4- and 8-leaf Quadris applications resulted in significant reduction in root rot rating and incidence (Table 3). However, there was no difference in yield, percent sucrose, recoverable sugar A^{-1} (RSA), or RST among treatments (Table 3). There was a significant at-planting by postemergence treatment interaction for root rot rating (Fig. 2); more impact of postemergence Quadris applications was observed on untreated seed or Systiva treated seed compared to treatments involving Quadris in-furrow application.

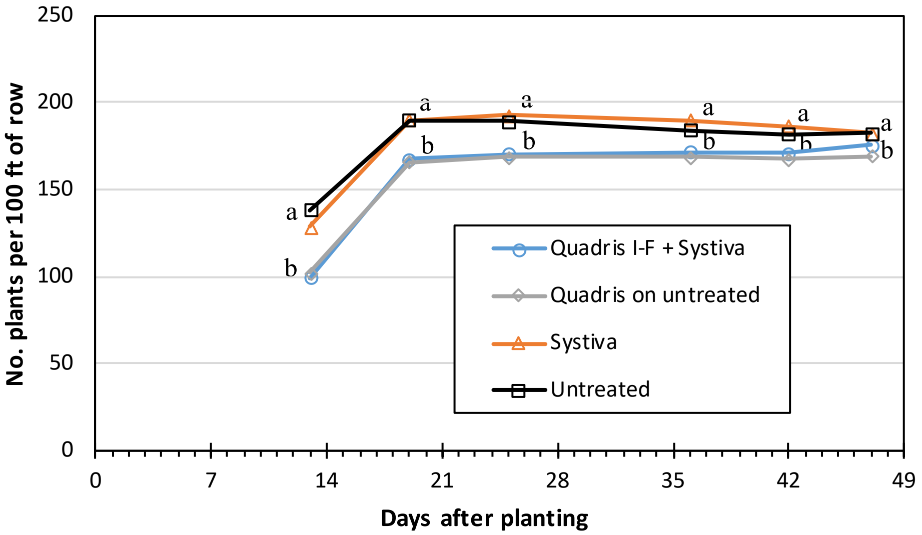

Fig. 1. NWROC site: Emergence and stand establishment for fungicide treatments at planting or untreated control. For each stand count date, values sharing the same letter are not significantly different (*P* = 0.05). Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

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	No. harv.	RCRR	RCRR %	Yield	Sucrose[T]		
(Apron + Maxim on all seed)	roots/100 ft[T]	(0-7)[TU]	incidence[TV]	ton A^{-1}[T]	%	lb ton^{-1}	lb A^{-1}
Variety[W]							
Resistant	142	0.11	1.4	19.9	17.8	336	6690
Moderately Susceptible	154	0.11	1.8	21.0	18.1	344	7211
ANOVA p-value	0.155	0.768	0.308	0.395	**0.001**	**0.004**	0.245
At-planting treatments[X]							
Untreated control	154	0.12	1.9	20.7	17.9	337	6993
Systiva	153	0.20	3.1	19.6	18.1	343	6703
Quadris In-furrow	140	0.04	0.2	19.8	18.0	341	6755
Systiva + Quadris I-F	145	0.08	1.0	21.8	17.8	337	7350
ANOVA p-value	**0.046**	0.061	0.124	0.064	0.222	0.184	0.134
LSD (*P* = 0.05)	10.3	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]							
None	145	0.20 a	3.3 a	20.1	17.9	339	6820
4-leaf Quadris	151	0.07 b	0.8 b	20.8	17.9	339	7065
8-leaf Quadris	148	0.06 b	0.6 b	20.4	18.0	341	6966
ANOVA p-value	0.353	**<0.0001**	**0.001**	0.157	0.288	0.325	0.213
LSD (*P* = 0.05)	NS	0.06	1.5	NS	NS	NS	NS
Vty x at-palnt	NS	NS	NS	NS	NS	NS	NS
Vty x Post	NS	NS	NS	NS	NS	NS	NS
At-plant x Post	NS	**0.017**	NS	NS	NS	NS	NS
Vty x At-plant x Post	NS	NS	NS	NS	NS	NS	NS

[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, 7 = 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)

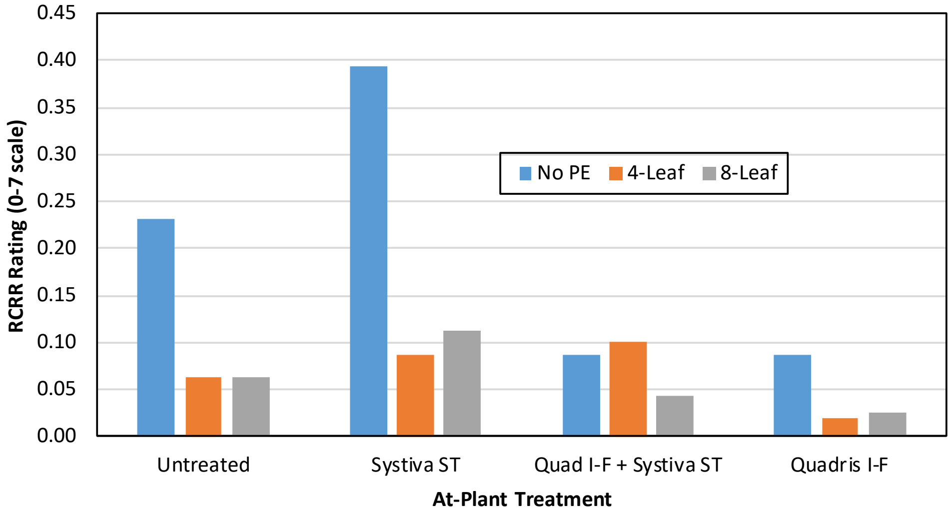

Fig. 2. NWROC site: Effect of at-panting and postemergence (PE) treatment interaction on Rhizoctonia root rot rating. Data shown represents mean of 8 plots averaged across varieties.

MDFC site: Late planting coupled with some moisture (Table 2) resulted in some early season disease pressure at this site. Resistant and moderately susceptible varieties had similar stands from 2 to 5.5 weeks after planting (WAP). Systiva and Systiva + Quadris I-F had significantly higher stands at 4 to 5 WAP compared to untreated control treatment (Fig. 3). At-plant control treatments had 180 plants/100 ft. row at 5.5 WAP indicating very low early season disease pressure at this site and yet Systiva had 201 and Systiva + Quadris had 216 plants/100 ft. row. Late planting (May 31) at this site did not result in stand reduction from Quadris in-furrow application (Fig. 3). However, Quadris in-furrow reduced stands at this site in 2018 (4). Even though July had substantial rainfall, relatively dry August resulted in low end-of the-season root rot development (Table 2). Resistant variety had significantly lower root rot rating and incidence, and lower purity compared to the moderately susceptible variety. Systiva + Quadris I-F had significantly lower root rot followed by untreated control and Systiva treatments (Table 4). No other harvest parameters were significantly different for at-planting treatments (Table 4). Postemergence Quadris application (4- or 8-leaf) significantly reduced root rot severity and incidence and increased yield and RSA compared to no postemergence application (Table 4). There was a significant variety x at-plant x postemergence treatment interaction for root rot rating (Figure 4). For the resistant variety, Quadris postemeregnce application may not be needed with Quadris I-F + Systiva, and 4- and 8-leaf Quadris postmeregence reduced root rot on untreated and Systiva treated seed with 8-leaf application resulting in slightly lower disease compared to 4-leaf post application. Whereas for the moderately susceptible variety, 4- or 8-leaf Quadris post reduced root rot with 4-leaf performing better on untreated and 8-leaf performing better on Quadris I-F + Systiva and Systiva treated seed (Figures 4A and 4B).

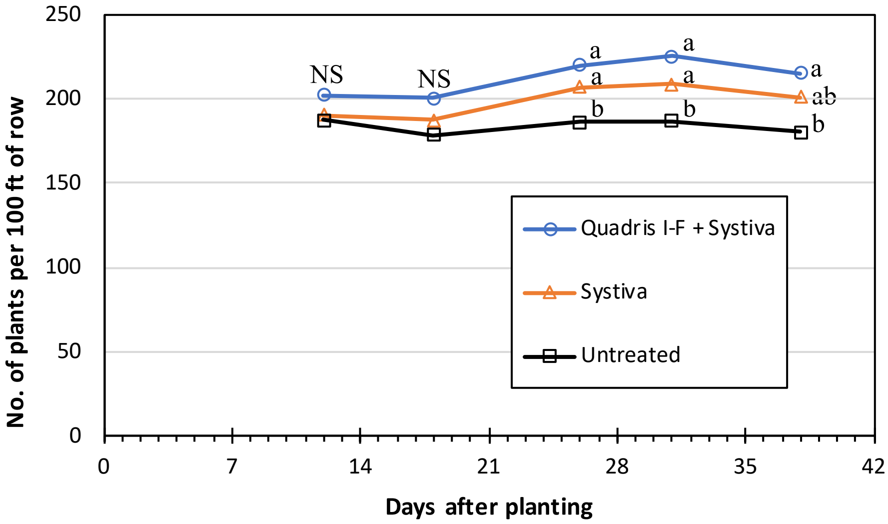

Fig. 3. MDFC site: Emergence and stand establishment for fungicide treatments at planting or untreated control. For each stand count date, values sharing the same letter are not significantly different (*P* = 0.05); NS = not significantly different. Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

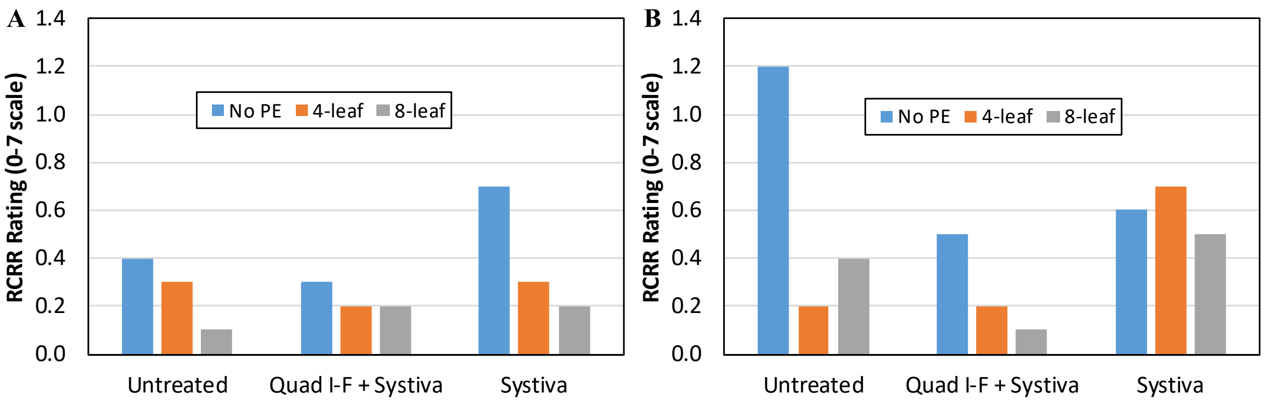

Fig. 4. MDFC site: Three way interaction of variety x at-plant x postemergence treatments for RCRR rating on the (A) resistant variety and (B) moderately susceptible variety. Data shown represents mean of 4 plots.

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 (0-7)[TU]	RCRR % incidence[TV]	Yield ton A^{-1}[T]	Sucrose[T] %	Sucrose[T] lb ton^{-1}	Sucrose[T] lb A^{-1}
Variety[W]						
Resistant	0.3	2.9	23.6	14.6	231	5434
Moderately Susceptible	0.5	9.0	22.3	14.8	238	5315
ANOVA p-value	**0.023**	**0.025**	0.391	0.434	0.246	0.658
At-planting treatments[X]						
Untreated control	0.4 ab	6.3	23.2	14.6	233	5405
Systiva	0.5 b	8.1	23.0	14.7	235	5395
Systiva + Quadris I-F	0.3 b	3.5	22.7	14.7	235	5324
ANOVA p-value	**0.033**	0.088	0.894	0.590	0.690	0.955
LSD (*P* = 0.05)	0.17	NS	NS	NS	NS	NS
Postemergence fungicide[Y]						
None	0.6 a	10.6 a	21.6 b	14.7	234	5053 b
4-leaf Quadris	0.3 b	4.2 b	24.0 a	14.7	236	5628 a
8-leaf Quadris	0.3 b	3.1 b	23.3 a	14.7	234	5442 a
ANOVA p-value	**<0.0001**	**0.0004**	**0.0006**	0.774	0.869	**0.0008**
LSD (*P* = 0.05)	.016	3.7	1.1	NS	NS	285
Vty x At-plant	NS	NS	NS	NS	NS	NS
Vty x Post	NS	NS	NS	NS	NS	NS
At-plant x Post	NS	NS	NS	NS	NS	NS
Vty x At-plant x Post	**0.022**	NS	NS	NS	NS	NS

[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, 7 = 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: Low rainfall during June only resulted in slight disease pressure early in the season (Table 2). Resistant variety had higher stands at 2, 4, and 6 WAP compared to moderately susceptible variety (Fig. 5). Systiva and Systiva + Quadris I-F had highest stands at 2, 4, and 6 WAP compared to untreated control treatment. Untreated control had 213 plants/100 ft. row at 7 WAP indicating very low early season disease pressure at this site and hence Systiva and Systiva + Quadris I-F had 222 and 225 plants/100 ft. row, respectively (Fig. 6). In contrary to 2018 observations (4), Quadris I-F did not reduce stands at this site in 2019. Less than normal rainfall during July and some rainfall in Aug (Table 2) resulted in some late season disease pressure at this site. Variety by postemergence interaction was observed for number of harvested roots, root rot rating, incidence, yield and RST (Table 5); (i) postemergence application had significant benefit on the moderately susceptible variety (ii) Both 4- and 8-leaf application were effective on resistant variety, while on the moderately susceptible variety most benefit was seen with the 8-leaf postemergence application (Figs. 7A, 7B and 7C). At-panting by postemergence interaction on yield was observed (Table 5); postemergence applications significantly improved yield parameters in treatments with no Quadris in-furrow application (Fig 8) and 4-leaf Quadris application looked better on untreated and Systiva treated seed compared to 8-leaf application on

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 (Apron + Maxim on all seed)	RCRR (0-7)[TU]	RCRR % incidence[TV]	Yield ton A^{-1}[T]	Sucrose[T]		
				%	lb ton^{-1}	lb A^{-1}
Variety[W]						
Resistant	0.3	5.8	26.9	15.7	256	6886
Moderately Susceptible	0.8	17.1	27.6	15.8	263	7243
ANOVA p-value	**0.005**	**0.001**	0.465	0.578	0.166	0.095
At-planting treatments[X]						
Untreated control	0.6	13.3	27.0	15.5	253	6842
Systiva	0.7	13.5	26.9	16.0	266	7160
Systiva + Quadris I-F	0.4	7.5	27.8	15.7	259	7191
ANOVA p-value	0.085	0.090	0.099	0.183	0.299	0.291
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]						
None	1.1 a	23.5 a	26.2 b	15.3 b	247 b	6468 b
4-leaf Quadris	0.4 b	8.5 b	27.9 a	15.9 a	265 a	7384 a
8-leaf Quadris	0.1 c	2.3 c	27.6 a	16.0 a	266 a	7341 a
ANOVA p-value	<0.0001	<0.0001	<0.0001	0.0004	0.001	<0.0001
LSD (*P* = 0.05)	0.24	4.9	0.65	0.31	10.8	288
Vty x at-plant	NS	NS	NS	NS	NS	NS
Vty x Post	**0.022**	**0.015**	**0.008**	NS	**0.041**	NS
At-plant x Post	NS	NS	**0.031**	NS	NS	NS
Vty x at-plant x Post	NS	NS	NS	NS	NS	NS

[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, 7 = 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)

Quadris I-F + Systiva seed (Fig. 8). Variety by at-plant by postemergence interaction was observed for no. of harvested roots (Table 5); postemergence application resulted in higher no. of harvested roots for Quadris I-F + Systiva and untreated control treatments for the moderately susceptible variety, but this trend was not observed for the resistant variety. Similar benefit from postemergence Quadris application at this location was also evident in 2016 thru 2018 (4-6). This clearly demonstrates the importance of choosing a resistant variety for managing Rhizoctonia diseases. In fields with heavy Rhizoctonia pressure, Quadris in-furrow application on treated seed will provide better protection compared to seed treatment only as observed in this trial especially when using a susceptible variety for Rhizoctonia.

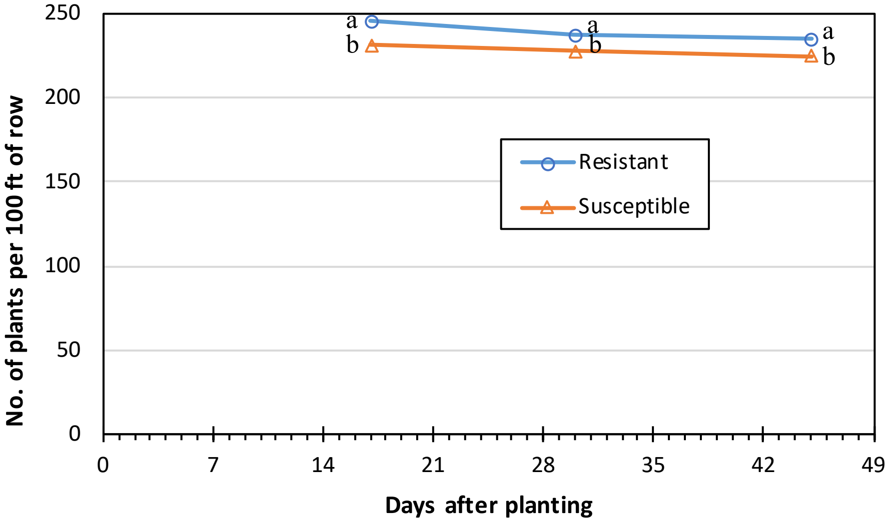

Fig. 5. SMBSC site: Emergence and stand establishment for resistant and moderately susceptible varieties. For each stand count date, values sharing the same letter are not significantly different ($P = 0.05$). Data shown represents mean of 36 plots averaged across at-planting and postemergence treatments.

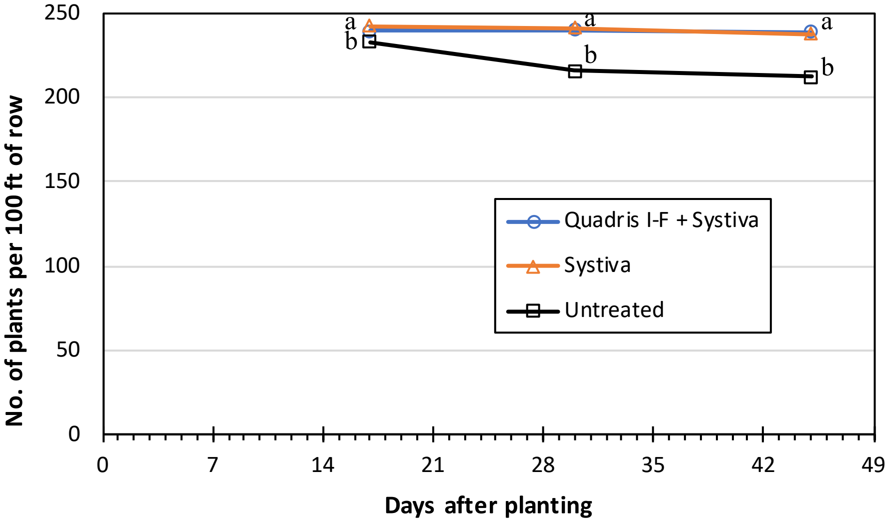

Fig. 6. SMBSC site: Emergence and stand establishment for the at-planting treatments. For each stand count date, values sharing the same letter are not significantly different ($P = 0.05$). Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

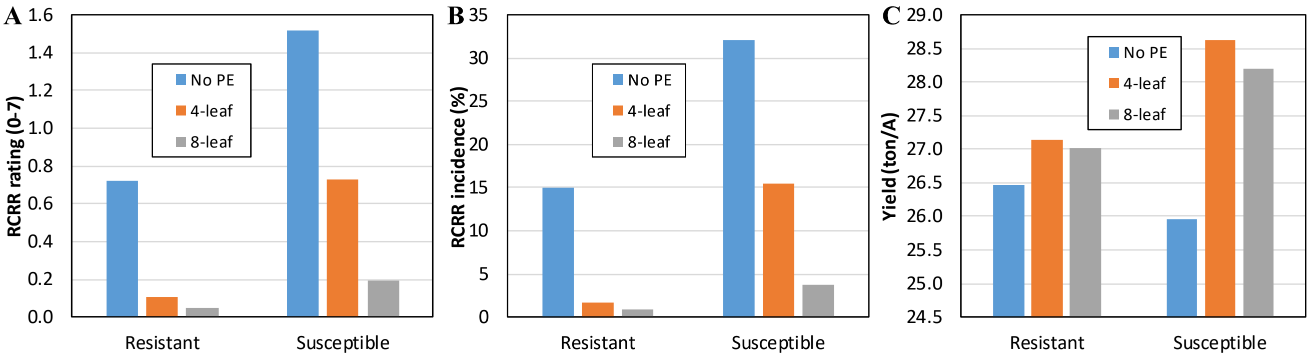

Fig. 7. SMBSC site: Effect of variety and postemergence treatments on **A)** RCRR rating (0 to 7 scale, 0 = root clean, no disease, 7 = root completely rotted and plant dead), **B)** RCRR incidence (% roots with rating > 2) and **C)** yield. Data shown represents mean of 12 plots averaged across at-planting treatments.

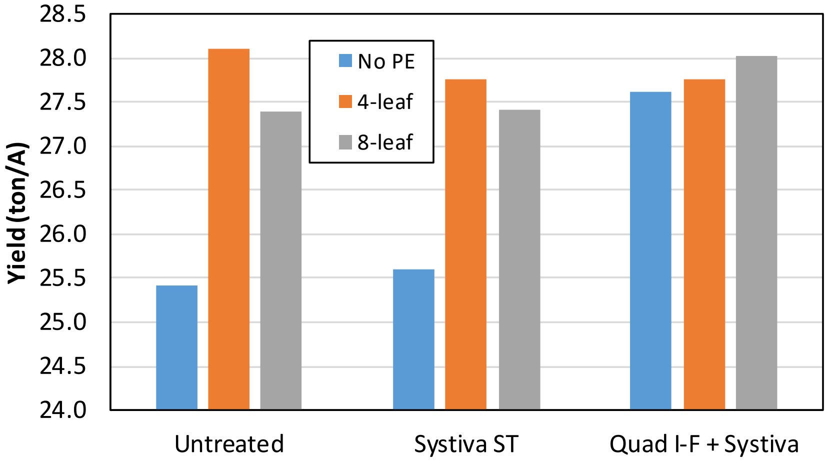

Fig. 8. SMBSC site: Effect of at-planting and postemergence treatments on root yield. Data shown represents mean of 8 plots averaged across varieties.

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LITERATURE CITED

1. Brantner, J.R. 2019. Plant pathology laboratory: summary of 2017-2018 field samples. 2018 Sugarbeet Res. Ext. Rept. 49:202-203.
2. Brantner, J.R. and Chanda, A.K. 2017. Plant pathology laboratory: summary of 2015-2016 field samples. 2016 Sugarbeet Res. Ext. Rept. 41:260-261.
3. Brantner, J.R., H.R. Mickelson, and E.A. Crane. 2014. Effect of *Rhizoctonia solani* inoculum density and sugarbeet variety susceptibility on disease onset and development. 2013 Sugarbeet Res. Ext. Rept. 44:203-208.
4. Chanda, A. K., Brantner, J. R., Metzger, M., Bloomquist, M., and Mettler, D. 2019. Integrated Management of Rhizoctonia on Sugarbeet with Varietal Resistance, At-Planting Treatments and Postemergence Fungicides. 2018 Sugarbeet Res. Ext. Rept. 49:166-175.
5. Chanda, A. K., Brantner, J. R., Metzger, M., Bloomquist, M., and Groen, C. 2018. Integrated Management of Rhizoctonia on Sugarbeet with Varietal Resistance, At-Planting Treatments and Postemergence Fungicides. 2017 Sugarbeet Res. Ext. Rept. 48:129-136.
6. Chanda, A. K., Brantner, J. R., Metzger, M., Bloomquist, M., and Groen, C. 2017. Integrated Management of Rhizoctonia on Sugarbeet with Varietal Resistance, At-Planting Treatments and Postemergence Fungicides. 2016 Sugarbeet Res. Ext. Rept. 47:174-179.
7. Niehaus, W.S. 2019. Results of American Crystal's 2018 Official Coded Variety Trials. 2018 Sugarbeet Res. Ext. Rept. 49:206-263.

Appendix. Trials conducted in the SMBSC growing area but not reported in the 2019 Research Reports.

Trial	Location	Description
Sugar Enhancement Trial	Redwood Falls	This trial was designed to evaluate the effect of several products on sugar content. Excessive rainfall caused plant stunting and variable growth. The trial was abandoned and some of the treatments were used in a new Sugar Enhancement Trial at the Murdock location reported on page 35.
CLS x Fertility Trial	Buffalo Lake	This trial evaluated CLS control in a program setting in combination with different preplant nitrogen and foliar nutrient products. Excessive rainfall caused variable stand and subsequently unreliable data.
CLS Program Trial	Buffalo Lake	This trial evaluated fungicides for CLS control in a program setting and was a duplicate of the Program Trial conducted in Bird Island with a few less treatments. Excessive rainfall caused variable stand and subsequently unreliable data. The data from the duplicate trial near Bird Island is reported on page 77.
CLS Variety Tolerance Trial	Buffalo Lake	This trial evaluated CLS control in a program setting with varying levels of variety genetic tolerance to CLS. Excessive rainfall caused variable stand and subsequently unreliable data.
Nitrification Inhibitor Trial	Murdock	This trial evaluated the effectiveness of a nitrification inhibitor product at different fertility rates. As a propriety trial all data was collected and delivered to the company funding the research.
Aphanomyces Seed Treatment Trial	Hector	This trial evaluated the effectiveness of a new seed treatment product to control Aphanomyces. As a propriety trial all data was collected and delivered to the company funding the research.
Seed Treatment Trial	Lake Lillian	This trial evaluated the effectiveness of seed treatment products to boost plant health and yield. As a propriety trial all data was collected and delivered to the company funding the research.
Application Methods Trial	Bird Island	This trial was designed to evaluate the effectiveness of a fungicide program in controlling CLS when using different nozzle, pressure, and volume configurations. Further research needs to be done concerning the proper materials and methods for conducting this type of a trial.
Population by Fertility Trial	Redwood Falls and Murdock	These trials were conducted to evaluate the ability of a grower to raise planting populations to counteract the negative effects of high nitrogen fertility on sugar beet quality. Both trials were harvested, but data was not published as this experiment will be continued in 2020 and all data combined and reported at that time.
Official Variety Trial	Wood Lake	This site was inundated with rain which caused the entire site to be abandoned. The Official Variety Trial is used in Seed Approval at SMBSC. Wood Lake was one of four locations for the OVTs in 2019, and the combined data from the remaining three trials can be found on page 6.
SES VanderHave Proprietary Trials (7)	Murdock, Wood Lake, Lake Lillian, Hector	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 (4)	Murdock, 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.