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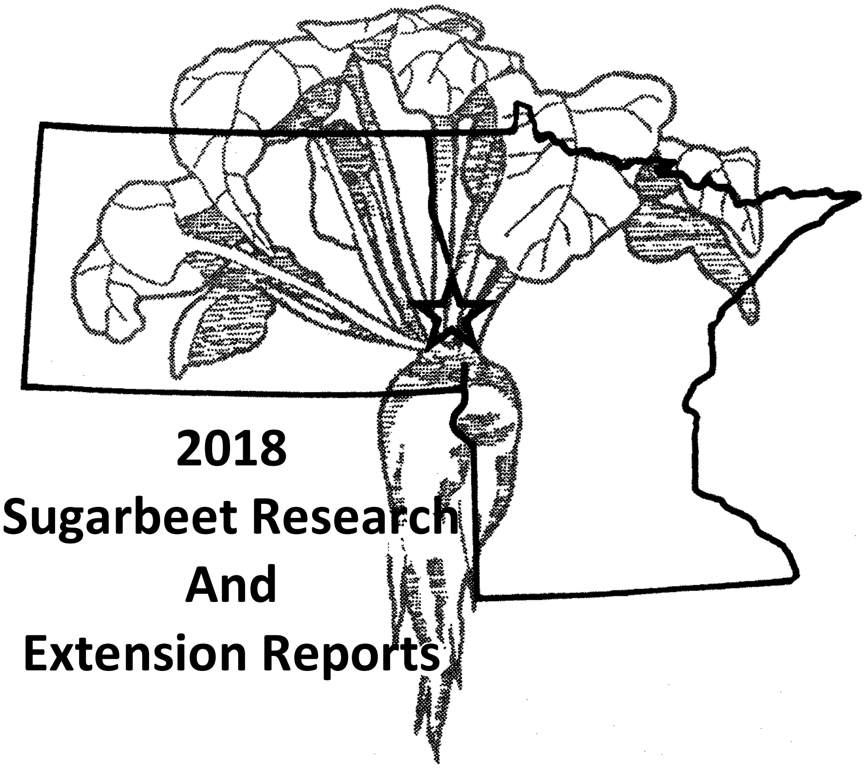

2018
Sugarbeet Research
And
Extension Reports

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WEED CONTROL

NOTES

TURNING POINT SURVEY OF WEED CONTROL AND PRODUCTION PRACTICES IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2017

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The third annual weed control and production practices live polling questionnaire was conducted using Turning Point Technology at the 2018 winter Sugarbeet Grower Seminars. Responses are based on production practices from the 2017 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 198,500 acres reported by 313 respondents (Table 6) compared to 158,272 acres represented in 2016. The average sugarbeet acreage per respondent grown in 2017 was calculated from Table 5 at 634 acres compared to 673 acres in 2016.

Survey participants were asked a series of questions regarding their production practices used in sugarbeet in 2017. Fifty-two percent of respondents indicated wheat was the crop preceding sugarbeet (Table 7), 28% indicated corn, and 8% indicated soybean. Preceding crop varied by location with 75% of Fargo growers indicating wheat preceded sugarbeet and 81% of Willmar growers indicated corn as their preceding crop. Seventy-four percent of growers who participated in the winter meetings used a nurse or cover crop in 2017 (Table 8), which decreased from 79% in 2016. Cover crop species also varied widely by location with oat being used by 53% of growers at the Willmar meeting and no cover crop being used by the majority (35%) of growers at the Grand Forks meeting.

Growers indicated Rhizoctonia was their most serious production problem in sugarbeet in 2017 (Table 9) with 27% of all respondents naming Rhizoctonia compared to Cercospora Leaf Spot (CLS) being named most serious by 57% of all participants in 2016. Weather was the most serious problem for 21% of growers, mainly those in the northern valley, and weeds were named as most serious by 11% of responses.

Waterhemp was named as the most serious weed problem in sugarbeet in 2017 by 48% of respondents (Table 10) compared to 59% in 2016. Seven percent of respondents indicated common lambsquarters, 5% kochia, and 20% said common ragweed were their most serious weed problem. 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 80% and 75% of Willmar and Wahpeton respondents, respectively, indicating waterhemp was most problematic weed. Common ragweed was the worst weed for respondents of the Grand Forks meeting with 48% of responses.

Respondents to the survey indicated making 0 to 5 glyphosate applications in their 2017 sugarbeet crop (Table 11) with a calculated average of 2.21 applications per acre. The calculated average in 2016 was 2.28 applications per acre.

Glyphosate was most commonly applied with a chloroacetamide herbicide postemergence (lay-by) in 2017 with 34% of responses indicating this herbicide combination was used (Table 12). Seventy-five percent and 52% of Willmar and Wahpeton respondents, respectfully, applied glyphosate with Outlook, S-metolachlor, or Warrant but only 27%, 1% and 0% of Fargo, Grand Forks, and Grafton respondents, respectfully, used this combination. Use of chloroacetamides with glyphosate seems to coincide greatest to areas where glyhphosate-resistant waterhemp is common. Glyphosate alone and glyphosate plus a broadleaf herbicide were tied for the second most common herbicide used in sugarbeet in 2017 with 28% of responses, followed by glyphosate plus a grass herbicide for 4% of the responses. Satisfaction to weed control from glyphosate applied alone is shown in Table 13 and ranged from

21% of responses indicating excellent control to 4% of responses indicating poor weed control. The majority of responses, 37%, indicated glyphosate was still providing good weed control in sugarbeet in 2017.

Preplant incorporated (PPI) or preemergence (PRE) herbicides were applied by 33% of survey respondents in 2017 (Table 14). Less than 10% of Grafton and Grand Forks survey participants applied a PPI or PRE herbicide. Conversely, 83% of Wahpeton survey participants did apply a PPI or PRE herbicide in sugarbeet in 2017 compared to 75% in 2016. 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 16% of all responses followed by ethofumesate with 7% of responses (Table 15). Of the growers who indicated using a soil-applied herbicide, 80% indicated excellent to good weed control from that herbicide (calculated from Table 15).

The application of soil-residual herbicides applied 'lay-by' to the 2017 sugarbeet crop was indicated by 51% of respondents (Table 16). Outlook was the most commonly applied lay-by herbicide with 30% of responses. The majority of growers responding at the Willmar meeting indicated using Outlook (77% of responses), while S-metolachlor was more commonly applied by growers of the Fargo (38% of responses) and Wahpeton (66% of responses) meetings. Satisfaction of weed control from lay-by applications ranged from excellent to unsure (Table 17). Of respondents indicating they applied a lay-by herbicide, 85% indicated excellent or good weed control (calculated from Table 17).

Forty-six percent of survey respondents indicated using some form of mechanical weed control or hand labor in 2017 (Table 18). Of the responses given, 26% indicated at least some hand-weeding, 16% used row-cultivation, and 2% indicated using a rotary hoe for weed control in sugarbeet. Thirteen percent reported row-crop cultivation on less than ten percent of their acres (Table 19). Respondents who cultivated generally reported good to fair weed control from the cultivation (Table 20).

Hand-weeding the 2017 sugarbeet crop was reported by 41% of respondents (Table 21). Most respondents who hand-weeded indicated less than 10% of their acres were hand-weeded. Fewer than half of the respondents indicated hand-weeding at the Grafton, Wahpeton, Grand Forks, and Fargo meetings, while greater than half the participants at the Willmar meeting reported some hand weeding. For growers who reported hand-weeding, 82% reported 'excellent' or 'good' hand-weeding control (Table 22).

Table 1. 2018 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County		Number of Responses	Percent of Responses
Becker		2	4
Cass		7	14
Clay		11	23
Norman[1]		22	45
Richland		1	2
Steele		1	2
Traill		4	8
Wilkin[2]		1	2
	Total	49	100

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

Table 2. 2018 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Grand Forks	5	8
Kittson	7	11
Marshall	5	8
Pembina	16	27
Polk	1	2
Ramsey	1	2
Walsh	25	42
Total	60	100

Table 3. 2018 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Grand Forks	23	29
Mahnomen	1	1
Marshall	10	12
Polk	35	43
Traill	4	5
Walsh	3	4
Other	5	6
Total	81	100

Table 4. 2018 Wahpeton Grower Seminar - Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Clay	2	5
Grant	5	12
Richland	10	24
Traverse	2	5
Wilkin	22	54
Total	41	100

Table 5. 2018 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Chippewa	34	34
Kandiyohi	15	15
Redwood	5	5
Renville	31	31
Stevens	4	4
Swift	7	7
Other	4	4
Total	109	100

Table 6. Total sugarbeet acreage operated by respondents in 2017.

Location	Responses	<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		Acres of sugarbeet									
		-------------------------------------% of responses----------------------------------									
Fargo	46	4	4	4	22	19	15	9	9	7	7
Grafton	56	4	14	7	20	23	14	5	7	4	2
Grand Forks	72	6	8	10	14	22	12	11	10	1	6
Wahpeton	40	0	12	12	15	15	12	18	10	3	3
Willmar	99	1	12	13	8	25	17	5	13	4	2
Total	313	3	11	10	14	22	15	9	10	3	3

Table 7. Crop grown in 2016 that preceded sugarbeet in 2017.

Location	Responses	Barley	Canola	Corn	Dry Bean	Potato	Soybean	Wheat	Other
		Previous Crop							
		---% of responses--							
Fargo	47	0	0	4	4	2	12	75	2
Grafton	59	2	0	0	3	13	2	80	0
Grand Forks	76	7	0	0	4	7	2	80	0
Wahpeton	42	5	0	24	0	0	16	55	0
Willmar	98	0	0	81	1	0	5	0	13
Total	322	2	0	28	2	4	8	52	4

Table 8. Nurse or cover crop used in sugarbeet in 2017.

Location	Responses	Barley	Oat	Rye	Wheat	Other[1]	None
		--------------------------------% of responses---------------------------					
Fargo	49	37	2	2	4	2	53
Grafton	56	30	18	0	25	2	25
Grand Forks	83	48	4	1	11	1	35
Wahpeton	40	53	0	2	25	2	18
Willmar	103	0	53	1	33	1	12
Total	331	29	21	1	21	2	26

[1]Includes Mustard and 'Other'

Table 9. Most serious weed problem in sugarbeet in 2017.

Location	Responses	CLS[1]	Rhizo-mania	Aph[2]	Rhizoc-tonia	Fusarium	Weeds	Herbicide Injury	Root Maggot	Weather	Stand[3]
		---% of responses---									
Fargo	47	22	2	6	49	0	11	0	2	6	2
Grafton	55	5	5	18	38	2	9	0	2	17	4
Grand Forks	66	15	1	3	23	0	5	0	0	52	1
Wahpeton	39	43	3	5	23	0	10	0	3	13	0
Willmar	102	37	7	4	15	1	17	1	0	13	5
Total	309	25	4	7	27	<1	11	<1	1	21	3

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

Table 10. Most serious weed problem in sugarbeet in 2017.

Location	Responses	biww[1]	colq	cora	Foxtail spp.	kochia	gira	rrpw	Smart weed	RR Canola	wahe
		--------	--------	--------	--------	--% of responses--	--------	--------	--------	--------	--------
Fargo	44	0	5	27	0	5	2	2	0	5	54
Grafton	55	5	5	18	38	2	9	0	2	17	4
Grand Forks	75	3	13	48	0	16	7	1	1	4	7
Wahpeton	41	0	5	13	0	2	0	0	2	2	76
Willmar	102	0	6	0	0	0	3	0	1	2	88
Total	317	2	7	20	7	5	4	<1	1	5	48

[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 2017 season.

Location	Responses	0	1	2	3	4	5
		--------	--------	--% of responses--	--------	--------	--------
Fargo	45	0	18	64	16	0	2
Grafton	56	0	14	66	20	0	0
Grand Forks	84	0	6	64	26	3	1
Wahpeton	39	0	13	54	31	2	0
Willmar	98	1	6	59	29	4	1
Total	322	<1	10	62	25	2	1

Table 12. Herbicides used in a weed control systems approach in sugarbeet in 2017.

Location	Responses	Glyphosate Application Tank-Mixes					
		Gly Alone	Gly+Lay-by	Gly+Broadleaf	Gly+Grass	Other	None Used
		--------	--------	--% of responses--	--------	--------	--------
Fargo	48	15	27	46	2	4	6
Grafton	56	68	0	14	4	4	10
Grand Forks	81	42	1	54	1	1	1
Wahpeton	40	10	52	25	8	5	0
Willmar	107	8	75	8	6	3	0
Total	332	28	34	28	4	3	3

Table 13. Satisfaction in weed control from glyphosate applied in sugarbeet in 2017.

Location	Responses	Satisfaction of Weed Control from Glyphosate					
		Excellent	Good	Fair	Poor	Unsure	Not Used Alone
		--------	--------	--% of responses--	--------	--------	--------
Fargo	46	9	50	22	2	4	13
Grafton	53	54	40	4	0	0	2
Grand Forks	82	38	39	10	0	1	12
Wahpeton	42	0	47	19	5	5	24
Willmar	102	3	24	22	10	2	39
Total	325	21	37	15	4	2	21

Table 14. Preplant incorporated and preemergence herbicides used in sugarbeet in 2017.

Location	Responses	PPI or PRE Herbicides Applied					
		S-metolachlor	ethofumesate	Ro-Neet SB	S-metolachor +ethofumesate	Other	None
		--------------------------------------% of responses----------------------------------					
Fargo	41	29	2	0	2	8	59
Grafton	53	0	0	0	0	6	94
Grand Forks	78	3	0	0	0	0	97
Wahpeton	34	62	3	0	15	3	17
Willmar	101	13	18	0	10	9	50
Total	307	16	7	0	5	5	67

Table 15. Satisfaction in weed control from preplant incorporated and preemergence herbicides in 2017.

Location	Responses	PPI or PRE Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		------------------------------% of responses-------------------------					
Fargo	45	7	20	11	4	0	58
Grafton	52	0	0	0	0	0	100
Grand Forks	68	1	1	1	0	0	96
Wahpeton	39	33	41	5	5	0	16
Willmar	100	5	37	8	0	1	49
Total	304	7	21	5	1	<1	65

Table 16. Soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2017.

Location	Responses	Lay-by Herbicides Applied				
		S-metolachlor	Outlook	Warrant	Other	None
		--% of responses-------------------------------------				
Fargo	45	38	2	0	2	58
Grafton	48	2	2	2	2	92
Grand Forks	74	1	4	0	0	95
Wahpeton	41	66	27	5	0	2
Willmar	101	2	77	16	0	5
Total	309	16	30	6	1	47

Table 17. Satisfaction of weed control from soil-residual herbicides applied early postemergence (lay-by) in sugarbeet in 2017.

Location	Responses	Lay-by Weed Control Satisfaction					
		Excellent	Good	Fair	Poor	Unsure	None Used
		--------------------------------% of responses---------------------------					
Fargo	47	2	26	8	0	2	62
Grafton	46	0	0	0	0	0	100
Grand Forks	32	3	0	3	0	3	91
Wahpeton	39	15	64	18	0	0	3
Willmar	100	13	72	10	0	0	5
Total	264	8	41	8	0	1	42

Table 18. Mechanical weed control methods used in sugarbeet in 2017.

Location	Responses	Rotary Hoe	Row-Cultivation	Hand-Weeded	Other	None
		----------% of responses----------				
Fargo	48	0	6	31	2	61
Grafton	49	0	4	10	0	86
Grand Forks	76	3	6	24	3	64
Wahpeton	42	0	12	21	10	57
Willmar	110	4	34	35	0	27
Total	325	2	16	26	2	54

Table 19. Percent of sugarbeet acres row-crop cultivated in 2017.

		% Acres Row-Cultivated				
Location	Responses	0	< 10	10-50	51-100	>100
		----------% of responses----------				
Fargo	50	82	8	8	0	2
Grafton	53	83	9	4	0	4
Grand Forks	78	78	18	3	1	0
Wahpeton	42	80	10	10	0	0
Willmar	101	46	14	12	11	17
Total	324	70	13	7	4	6

Table 20. Satisfaction of weed control from row-crop cultivation in sugarbeet in 2017.

Location	Responses	Excellent	Good	Fair	Poor	Unsure	No Row-Cultivation
		----------% of responses----------					
Fargo	45	0	4	7	2	2	85
Grafton	52	6	6	4	0	2	82
Grand Forks	47	2	11	8	0	0	79
Wahpeton	41	2	5	10	5	0	78
Willmar	100	5	22	19	2	2	50
Total	285	4	12	11	2	1	70

Table 21. Percent of sugarbeet acres hand-weeded in 2017.

		% Acres Hand-Weeded				
Location	Responses	0	< 10	10-50	51-100	>100
		----------% of responses----------				
Fargo	49	59	25	10	2	4
Grafton	50	82	16	0	2	0
Grand Forks	80	61	30	5	3	1
Wahpeton	43	72	21	7	0	0
Willmar	100	40	22	26	8	4
Total	322	59	23	12	4	2

Table 22. Satisfaction of weed control from hand-weeding sugarbeet in 2017.

Location	Responses	Excellent	Good	Fair	Poor	Unsure	No Hand-Weeding
		---------------------------------% of responses---------------------------					
Fargo	39	13	20	0	8	0	59
Grafton	49	10	10	0	0	0	80
Grand Forks	64	25	12	2	0	0	61
Wahpeton	43	14	5	7	0	0	74
Willmar	100	9	34	13	0	1	43
Total	295	14	19	6	1	<1	60

INTER-ROW CULTIVATION TIMING EFFECT ON SUGARBEET YIELD AND QUALITY IN 2018

Nathan H. Haugrud[1] and Thomas J. Peters[2]
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Summary
Field experiments were conducted to determine if cultivation at 1.5 to 2 inches deep at 4 MPH negatively affects sugarbeet root yield and quality. Cultivation did not affect sugarbeet density, root yield, sucrose content, or recoverable sucrose per acre at three environments in 2018.

Introduction and Objectives

Sugarbeet producers have renewed their interest in inter-row cultivation due to the development of glyphosate resistant waterhemp (*Amaranthus tuberculatus)* in Minnesota and North Dakota. However, producers are concerned about how mid-season cultivation affects sugarbeet yield and disease pressure.

Research conducted by Alan Dexter and Joe Giles in the 1980s and 1990s generally demonstrated early-season cultivation has little effect on recoverable sucrose yield, but cultivation later in the season is detrimental to yield and quality (Dexter et al. 2000). Dexter (1983) reported sugarbeet yield tended to increase with up to three cultivations, but decreased after four cultivations. Giles et al. (1987) reported increasing cultivation number from one to four numerically reduced yield in one of two environments. Giles et al. (1990) reported one to three cultivations had no effect on sugarbeet yield, but there was an increasingly negative effect on sugarbeet yield as cultivation number increased from four to seven in one of two environments.

Sugarbeet producers frequently used inter-row cultivation to control herbicide-resistant weeds in 2018 (Peters et al. 2018). Many producers currently consider one to two mid-season cultivation passes a "rescue" strategy rather than a primary weed control method. The objectives of this experiment were to 1) evaluate the effect of inter-row cultivation timing and number of passes on sugarbeet yield and quality and 2) evaluate if inter-row cultivation timing and number of passes increases severity of *Rhizoctonia solani* on sugarbeet.

Materials and Methods

Site Description. Field experiments were conducted in three environments in 2018. The three environments were on producer fields near Glyndon, MN (46°51'52.7"N, 96°31'15.5"W), Hickson, ND (46°42'18.9"N, 96°48'08.1"W), and Amenia, ND (47°00'10.4"N, 97°06'21.9"W). Previous crop grown in fields were soybean, sugarbeet, and wheat at the Glyndon, Hickson, and Amenia fields, respectively. Soil descriptions for each environment can be found in Table 1.

Table 1. Soil descriptions for trial environments in 2018.

Environment	Soil series & texture	Organic matter	Soil pH
Amenia, ND	Bearden & Lindass silty clay loam mix	3.9%	8.0
Hickson, ND	Fargo silty clay	6.0%	7.5
Glyndon, MN	Wyndmere fine sandy loam	2.6%	8.2

Experimental Procedures. The experimental design was a randomized complete block with four replicates. Plots were 11 feet wide (6 rows) and 30 feet long. Treatments were applied every two weeks though the growing season starting June 21 and ending August 16. Treatments were cultivation dates with a maximum of three dates and an untreated control. Inter-row cultivation was performed to the center 4 rows of each plot using a modified Alloway 3130 cultivator (Alloway Standard Industries, Fargo, ND) with 15-inch sweep shovels spaced at 22 inches with a ground depth of 1.5 to 2 inches at 4 MPH.

'Crystal 355RR' sugarbeet seed (American Crystal Sugar Company, Moorhead, MN) was planted 1.25 inches deep at a density of 61,000 (+/- 1,000) seeds per acre in six rows spaced 22 inches apart. Planting dates were May 3, 2018 at Glyndon, May 7, 2018 at Hickson, and May 14, 2018 at Amenia. Sugarbeet seeds were treated with penthiopyrad (Kabina ST, Sumitomo Corporation, New York, NY). Nitrogen, phosphorus, and potassium fertilizer was applied based on spring soil tests and incorporated prior to planting. Weeds and disease were controlled so that crop injury from cultivation could be detected without interference from other yield-limiting factors. Weeds were controlled using glyphosate (Roundup PowerMAX, Monsanto Company, St. Louis, MO) at 32 oz per acre. No more than three glyphosate applications were made at each location and herbicide resistant waterhemp were removed by hand weeding. Root disease pressure from *Rhizoctonia solani* was controlled with soil-applied applications of azoxystrobin (Quadris, Syngenta Crop Protection, Greensboro, NC) at Amenia and Hickson. Disease pressure from *Cercospora beticola* was controlled with foliar applications of triphenyltin hydroxide (Super Tin 4L, United Phosphorus, Inc., King of Prussia, PA), thiophanate methyl (Topsin 4.5FL, United Phosphorus, Inc., King of Prussia, PA), and difenoconazole / propiconazole (Inspire XT, Syngenta Crop Protection, Greensboro, NC).

Data Collection and Analysis. Sugarbeet stand counts were collected in the center two rows of each plot prior to the start of cultivation treatments and prior to harvest to determine percent stand mortality throughout the season. Harvest dates were September 17, 2018 at Glyndon, September 11, 2018 at Hickson, and September 18, 2018 at Amenia. At harvest, sugarbeet was defoliated with a four-row topper and harvested with a two-row sugarbeet harvester. The sugarbeet roots harvested from the center two rows of each plot were weighed and a 20-lb sample was analyzed by American Crystal Sugar Company, East Grand Forks, ND for percent sucrose. Sugarbeet roots were visually analyzed for *Rhizoctonia* root and crown rot, but no visual infection was observed from any treatment at any location.

Data was subjected to analysis of variance using the MIXED procedure in SAS 9.4 (SAS Institute, Cary, NC) to test for treatment differences among means at $P \leq 0.05$. Cultivation treatment was considered a fixed effect, while environment and replicate were considered random effects. Environments were combined for analysis when mean square error values between environments were within a factor of ten. Single-cultivation and double-cultivation treatments were subject to regression analysis ($P \leq 0.05$) to detect relationships between cultivation timing and sugarbeet stand, yield, and quality, but no significant relationships were detected.

Results and Discussion

Field Growing Conditions. Field planting ranged between May 3 and May 14 across all environments (Table 2), which is typical for sugarbeet production in eastern North Dakota and Minnesota. Season-long precipitation at Amenia was slightly below the 30-year average, while Hickson and Glyndon received slightly above the 30-year average. However, sugarbeet at Amenia still had the greatest sucrose yield of all environments. Hickson received excessive hail on August 26 that destroyed 90% of the crop canopy which likely reduced root yield and sucrose content at harvest. Glyndon received only 0.6 inches of precipitation in the month following planting, which led to an erratic and non-uniform crop stand. Glyndon soil texture was a fine sandy loam with low organic matter, which likely contributed to moisture stress throughout the growing season. Sugarbeets at Glyndon were also noted to exhibit foliar potassium deficiency throughout the season, which was possibly due to inadequate fertilization rate, poor crop uptake, or both.

Table 2. Dates of planting and harvest, previously crop grown, and sugarbeet density at three environments in 2018.

Environment	Planting date	Harvest date	Previous crop	Sugarbeet density [a]
				# per 100 row-feet
Amenia, ND	May 14	September 18	Wheat	185
Hickson, ND	May 7	September 11	Sugarbeet	190
Glyndon, MN	May 3	September 17	Soybean	152

[a] Sugarbeet stand was counted prior to first treatment.

Sugarbeet Stand Density. Cultivation did not affect sugarbeet density at any environment in 2018 (Table 3). Environments were analyzed separately for stand mortality because mean square error values between environments were not within a factor of ten. Stand mortality at Amenia was relatively low, ranging from 11% to 21%, but no patterns were observed. The stand mortality at Hickson was relatively high, ranging from 30 to 40% (Table 3), but the stand mortality was consistent between treatments. The relatively high stand mortality at Hickson is probably due to sugarbeet being the previous crop grown on the field site. Planting sugarbeet into sugarbeet residue highly increases chance of infection from *Rhizoctonia solani* (Windels and Brantner 2008). Sugarbeet stand mortality was not observed at Glyndon (Table 3). Some sugarbeet roots at Glyndon were small and 6 to 8 leaves at harvest, indicating they had emerged mid-season. Sugarbeet were counted a just prior to the first cultivation on June 21, but sugarbeets continued to emerge randomly into the summer at Glyndon, making the stand mortality measurement negative in some treatments.

Table 3. Sugarbeet stand mortality affected by cultivation timing in 2018.

	Stand mortality [a]		
Cultivation timing	Amenia	Hickson	Glyndon
	-------------------------%-------------------------		
Control	15	32	-14
June 21	20	37	-1
July 5	15	37	4
July 19	20	41	-10
August 2	11	32	-1
August 16	13	30	10
June 21 + July 19	13	31	-7
July 5 + Aug 2	19	36	4
July 19 + Aug 16	21	39	7
June 21 + July 19 + Aug 16	16	37	7
ANOVA	---------------------*p value*---------------------		
Treatment	0.082	0.435	0.848

[a] Percent stand mortality is calculated by multiplying the ratio of harvest stand and pre-treatment stand by 100.

Harvested sugarbeet roots were visually inspected for root and crown rot from *R. solani*, but no infection was observed at any environment. Inter-row cultivation has historically been associated with root and crown rot since cultivation may physically deposit soil onto a beet crown, moving soil-borne pathogens nearer their host. Schneider et al. (1982) reported covering sugarbeet roots with soil via a cultivator moving 8 MPH in mid-August resulted in greater root rot due to *R. solani* in two of three field environments. Windels and Lamey (1998) reported reducing cultivation ground speed reduces chance of infection from *R. solani*. Some soil movement onto beet crowns was observed in this experiment, but the cultivation speed of 4 MPH used in this experiment was possibly not fast enough to cause significant root rot infection in these environments in 2018.

<u>*Sugarbeet Root Yield.*</u> Cultivation did not affect root yield at any environment (Table 4). Root yields were 37 to 40 tons/acre at Amenia, 16 to 23 tons/acre at Hickson, and 10 to 15 tons/acre at Glyndon. No statistical differences among treatments were measured across environments (P = 0.944). Inter-row cultivation only disturbs soil between the sugarbeet rows and does not significantly affect root growth or yield. Giles et al. (1990) conducted root excavations on sugarbeet in late-July and reported less root development and yield with treatments receiving five to seven weekly cultivations throughout the season in one of two environments. Giles et al. (1990) cultivated to a similar depth of 1.5 to 2 inches, but a ground speed of 3 MPH. Significant root yield reduction was not observed with up to three cultivations in this experiment cultivating 1.5 to 2 inches deep and 4 MPH. The yield loss Giles et al. (1990) reported in one of two environments was likely due a greater number of cultivations (five to seven) as compared to one, two, or three cultivations in the trials conducted in 2018.

<u>*Percent Sucrose Content.*</u> Cultivation did not affect sucrose content at any environment (Table 4). Sucrose percentages ranged from 15.7 to 16.3% in Amenia, 14.1 to 14.9% in Hickson, and 13.6 to 14.2% in Glyndon, with no significant differences among treatments. Combined analysis tended to demonstrate treatment differences between cultivation number and dates (P = 0.062), but no trends were observed. Regression analysis to determine if sucrose content was affected by cultivation timing was not significant (data not shown). Cultivator shanks traveling between sugarbeet rows during cultivation were observed to cause foliar damage, especially at later cultivation dates. Sugarbeet plants compensate for the foliar damage by producing new leaves, potentially lowering sucrose content, but this data demonstrates no reduction in sucrose content. Foliar damage was also noted from the tractor wheels traveling between plot rows. The tractor wheels in this experiment traveled on the outside of the plot area to remove the effect of the wheels from the results.

Table 4. Root yield, sucrose content, and recoverable sucrose per acre (RSA) affected by cultivation timing averaged across Amenia, Hickson, and Glyndon in 2018.

	Yield Components		
Cultivation timing	Root yield	Sucrose content	RSA
	Ton/acre	%	Lb/acre
Control	24.3	15.0	6,817
June 21	24.1	14.8	6,773
July 5	24.7	14.9	6,934
July 19	23.5	14.9	6,563
August 2	25.4	14.7	6,899
August 16	24.4	14.5	6,529
June 21 + July 19	24.3	14.5	6,679
July 5 + Aug 2	24.7	14.6	6,698
July 19 + Aug 16	23.5	14.8	6,472
June 21 + July 19 + Aug 16	23.5	14.8	6,540
ANOVA	---------------------------------*p value*----------------------------------		
Treatment	0.944	0.062	0.947

Recoverable Sucrose per Acre. Cultivation did not affect recoverable sucrose per acre at any environment (Table 4). Recoverable sucrose per acre (RSA) is a calculation derived from root yield and sucrose content. RSA ranged from 10,600 to 11,700 at Amenia, 4,500 to 6,000 at Hickson, and 2,400 to 3,900 at Glyndon. No treatment differences were measured in the combined analysis (P = 0.947). This result was expected since treatment means for root yield and sucrose content were not significantly different (Table 4).

Conclusion

Inter-row cultivation did not affect sugarbeet density, root yield, or quality at any environment in this experiment. This data suggests up to three cultivations performed as late as August 16 will not negatively affect sugarbeet yield. Most producers in 2018 only used cultivation to remove weeds that glyphosate did not control, so it is unlikely that, under current production practices, any sugarbeet producer would cultivate a field more than three times in one season. Most cultivations in 2018 were also done after the sugarbeet canopy closed in mid-July. The effect of inter-row cultivation on yield is likely a complex interaction of cultivation timing, soil type, environmental conditions, disease pressure, cultivation speed, and cultivation equipment.

Sugarbeet producers are concerned about yield loss from inter-row cultivation partially due to the past work done by Dexter and Giles. While the cultivation methods and procedures used in our experiment are similar to what Dexter and Giles implemented in their experiments, our timing of cultivation was different. Dexter and Giles conducted their cultivations on weekly intervals with the same start date, while our cultivations were two weeks apart with staggered starting dates and timings as late as August 16. Furthermore, certain aspects of sugarbeet production that could affect disease pressure are different from the 1980s and 1990s such as diploid genetics, seed treatments, and soil-applied applications of azoxystrobin. Our results show cultivation 1.5 to 2 inches deep at 4 MPH with soil-applied applications of azoxystrobin did not affect sugarbeet yield in 2018, but further research is needed in future years with different ground speeds, cultivator configurations, fungicide applications, and environmental conditions to better determine if cultivation could affect sugarbeet yield.

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INTER-ROW CULTIVATION IMMEDIATELY FOLLOWING RESIDUAL HERBICIDE APPLICATION IN SUGARBEET

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Summary

Sugarbeet producers have asked if cultivation immediately after their application of chloroacetamide (or "layby") herbicides affects the activity of the herbicides in addition to removing weeds. Field trials were conducted to evaluate the effectiveness of early cultivation and how cultivation interacts with residual herbicides as an incorporation tool. Cultivation removed 50 to 75% of herbicide-resistant waterhemp and did not affect the activity of residual herbicides with our cultivator configurations. Early cultivation before canopy closure did not affect waterhemp emergence, but did increase common lambsquarters emergence in one environment. Cultivation is not currently the preferred means to control common lambsquarters as a repeat glyphosate application is cost effective and more reliable.

Introduction and Objectives

Many sugarbeet producers in 2018 applied glyphosate and chloroacetamide herbicides in layers until crop canopy closure. Many producers have used inter-row cultivation as a supplement to their weed control program to remove weeds that glyphosate did not control. One limitation of chloroacetamide herbicides is their requirement for precipitation to become active in the soil. Because of this limitation, producers have inquired if cultivation can be used to activate their herbicides through incorporation. Producers would also like to know how cultivation affects weed emergence. Therefore, the objectives of this experiment were to 1) evaluate the effectiveness of cultivation at removing herbicide-resistant weeds in sugarbeet and 2) evaluate how immediate cultivation affects weed emergence and interacts with soil-residual herbicides in sugarbeet.

Materials and Methods

Site Description. Field experiments were conducted at two locations in eastern North Dakota and Minnesota in 2017 and at three locations in 2018. Each site-year combination was considered an environment. Environments in 2017 were near Wheaton, MN (45°47'11.0"N, 96°21'15.4"W) and Renville, MN (44°47'07.5"N, 95°08'20.2"W). Environments in 2018 were near Hickson, ND (46°42'14.2"N, 96°48'09.3"W), Galchutt, ND (46°21'31.7"N, 96°50'22.7"W), and Nashua, MN (46°02'43.2"N, 96°19'38.5"W). Detailed soil descriptions for each environment can be found in Table 1. The dominant weed at the Renville-2017, Hickson-2018, and Nashua-2018 environments was waterhemp, while the dominant weed at the Wheaton-2017 and Galchutt-2018 environments was common lambsquarters. The five environments were separated into two groups: waterhemp and common lambsquarters.

Table 1. Soil descriptions for environments in 2017 and 2018.

Environment	Soil series & texture	Soil subgroup	Organic Matter	Soil pH
Wheaton-2017	Doran & Mustinka loam mix	Aquertic Argiudolls & Typic Argiaquolls	5.1%	6.9
Renville-2017	Mayer silty clay loam	Typic Endoaquolls	7.7%	7.9
Hickson-2018	Fargo silty clay	Typic Epiaquerts	6.0%	7.5
Galchutt-2018	Wyndmere loam	Aeric Calciaquolls	5.0%	7.5
Nashua-2018	Croke sandy loam	Oxyaquic Hapludolls	3.5%	7.2

Experimental Procedures. The experiment was a 2x6 factorial split-block arrangement in a randomized complete block design with six replications. Each replication (block) was two factors, cultivation and herbicide treatment. Untreated plots were nested in the design for comparison. Sugarbeet was planted on May 15, 2017 at Renville, May 8, 2017 at Wheaton, May 7, 2018 at Hickson, May 14, 2018 at Nashua, and May 14, 2018 at Galchutt at a density of 61,000 (+/- 1,000) seeds per acre in plots that were 11 feet wide (six rows spaced 22 inches apart) and 30 feet long. S-metolachlor (Dual Magnum, Syngenta Crop Protection) at 0.5 pt/A was applied preemergence (PRE) within 48 hours after planting across the entire trial area in all environments except Hickson-2018 to minimize the effects of early season weed competition.

Herbicide treatments were applied at 4- to 10-leaf sugarbeet with a bicycle wheel-type sprayer with a shielded boom to reduce particle drift at a volume of 17 gal/A. The center four rows of each six-row plot were sprayed using pressurized CO_2 at 35 PSI through 8002XR nozzles (TeeJet Technologies, Glendale Heights, IL). Half of the treatments were cultivated immediately after herbicide application using a modified Alloway 3130 cultivator (Alloway

Standard Industries, Fargo, ND) with 15-inch sweep shovels spaced at 22 inches with a ground depth of 1.5 to 2 inches at 4 MPH. Information and use rates of herbicide can be found in Table 2. Dates of planting, herbicide application, and crop stage at herbicide application can be found in Table 3.

Table 2. Herbicide product information for treatments applied to 8- to 10-leaf sugarbeet in 2017 and 4- to 8-leaf sugarbeet in 2018.

Herbicide [a]	Product Rate	Trade name	Manufacturer [b]
	fl oz/A		
Glyphosate	28	Roundup PowerMAX	Monsanto
Glyphosate + S-metolachlor	28 + 20	Roundup PowerMAX + Dual Magnum	Monsanto + Syngenta
Glyphosate + dimethenamid-P	28 + 18	Roundup PowerMAX + Outlook	Monsanto + BASF
Glyphosate + acetochlor	28 + 52	Roundup PowerMAX + Warrant	Monsanto
Glyphosate + trifluralin	28 + 16	Roundup PowerMAX + Treflan HFP	Monsanto + Gowan
Glyphosate + cycloate	28 + 43	Roundup PowerMAX + Ro-Neet	Monsanto + Helm Agro

[a] Adjuvants: All treatments included ethofumesate at 4 oz/A (Ethofumesate 4SC, Willowood LLC), high surfactant methylated oil concentrate at 1.5 pt/A (Destiny HC, Winfield Solutions LLC), and ammonium sulfate liquid solution at 2.5% v/v (N-Pak AMS liquid, Winfield Solutions LLC).

[b] Manufacturer information: Monsanto Company, St. Louis, MO; Syngenta Crop Protection, Greensboro, NC; BASF Corporation, Research Triangle Park, NC; Gowan Company, Yuma, AZ; Helm Agro US, Tampa, FL.

Table 3. Planting dates, application dates, and crop stage of of sugarbeet across environments in 2017 and 2018.

		Application date		
Environment	Planting date	PRE [a]	POST	SGBT stage at POST
Renville, 2017	May 15	May 15	June 26	8-10 leaf
Wheaton, 2017	May 8	May 9	June 27	8-10 leaf
Hickson, 2018	May 7	-	June 20	6-8 leaf
Nashua, 2018	May 14	May 15	June 8	4-6 leaf
Galchutt, 2018	May 14	May 15	June 8	4-6 leaf

[a] Abbreviations: PRE = preemergence; POST = postemergence; SGBT = sugarbeet.

Data Collection and Analysis. Percent weed control was evaluated as 'overall control' and 'new weed emergence control' at 14, 28, and 42 (+/- 3) days after treatment (DAT). Evaluation was a scale of 0% (no control) to 100% (complete control) relative to the untreated check rows between treatments. 'New weed emergence control' evaluated weeds that emerged since the last treatment, while 'overall control' evaluated old and new growth. Waterhemp in the 7-foot by 30-foot treated area of each 11-foot by 30-foot plot was counted 14 and 28 DAT at the Renville-2017, Hickson-2018, and Nashua-2018 environments. Waterhemp plants counted were considered glyphosate resistant because only plants that emerged prior to herbicide application were counted and all herbicide treatments included glyphosate. Seedlings were evaluated as part of 'new weed emergence control'. Common lambsquarters density was determined by counting plants in a 1-m^2 quadrat 14 and 28 DAT at the Galchutt-2018 environment. Sugarbeet density was determined by counting stand in treated rows.

Statistical analysis was conducted using SAS 9.4 (SAS Institute, Cary, NC). Data was subjected to ANOVA using PROC MIXED to test for treatment differences and significant interactions. Data was analyzed as a split-block design with expected means squares as recommended by Carmer et al. (1989). Significantly different treatment means were separated using t-tests when data was found to be significantly different at the $P \leq 0.05$. The cultivation and herbicide treatment factors were considered fixed effects, while replicate and environment were considered random effects. All environments were analyzed separately because of differences in primary weed species, precipitation, sugarbeet density, and sugarbeet stage at which the treatments were applied. Only main effects are presented when no significant cultivation by herbicide interaction was detected.

Results and Discussion

Field Growing Conditions. Field planting ranged between May 8 and May 15 across all environments (Table 3), which is typical for sugarbeet production in eastern North Dakota and Minnesota. Precipitation in the weeks following planting in 2017 was near the 30-year average, but 2018 was dry in two of three environments. Stand establishment was a production challenge for sugarbeet producers in 2018 because of this dry period immediately following planting. Sugarbeet density in most environments were near the optimal range of 172 to 197 sugarbeets per

100 ft row (Cattanach 1994; Smith et al. 1990; M. Metzger 2018, personal communication), but the sugarbeet density at Nashua-2018 was 35% of the recommended density (Table 4). Sugarbeet density at Galchutt-2018 was non-uniform with frequent and random gaps, despite having a density at 85% of the recommended range. Hickson-2018 received 1/3rd inch of rain immediately after planting and one inch the week following planting that contributed to normal densities. Crop density is an important component of sugarbeet weed management (Dawson 1977) and the poor and non-uniform sugarbeet density at Nashua-2018 and Galchutt-2018 likely reduced the contribution of crop canopy for weed suppression.

Table 4. Primary weed species present and sugarbeet density at environments in 2017 and 2018.

Environment	Primary weed species	Sugarbeet density [a]
		# per 100 ft row
Renville-2017	Waterhemp	166
Wheaton-2017	Common lambsquarters	194
Hickson-2018	Waterhemp	187
Nashua-2018	Waterhemp	65
Galchutt-2018	Common lambsquarters	158

[a] Sugarbeet density is average number of sugarbeet plants per 100 ft of row.

Waterhemp density per plot. Cultivation immediately following herbicide application reduced waterhemp number of plants per plot by 50 to 75% across all environments when assessed 14 DAT (Table 5). Cultivated plots had 50 to 80% fewer waterhemp at 28 DAT per plot compared to non-cultivated plots across all environments. This result was expected because the cultivator with 15-inch wide shovels in 22-inch rows covered approximately 68% of field surface area. The primary value of cultivation is the physical removal of weeds that glyphosate will not control. Only plants that emerged prior to herbicide application were counted to determine the removal of herbicide resistant weeds. Herbicide treatment did not affect waterhemp counts in any environment season-long because most waterhemp biotypes in eastern North Dakota and Minnesota are glyphosate resistant.

Table 5. Effect of cultivation and herbicide on waterhemp density at Renville-2017, Hickson-2018, and Nashua-2018, 14 and 28 days after treatment (DAT). [a]

	Waterhemp counts, 14 DAT			Waterhemp counts, 28 DAT		
Main effects	Renville	Hickson	Nashua	Renville	Hickson	Nashua
Cultivation	-------------# per plot-------------			-------------# per plot-------------		
With cultivation	2 a	1 a	2 a	3 a	1 a	2 a
No cultivation	6 b	4 b	4 a	7 b	5 b	4 b
Herbicide						
Glyphosate	6 a	2 a	5 a	6 a	3 a	5 a
Glyphosate + S-metolachlor	3 a	1 a	3 a	5 a	3 a	3 a
Glyphosate + Outlook	3 a	3 a	1 a	3 a	2 a	2 a
Glyphosate + Warrant	4 a	2 a	3 a	5 a	2 a	4 a
Glyphosate + Treflan	5 a	4 a	1 a	7 a	3 a	3 a
Glyphosate + Ro-Neet	3 a	4 a	3 a	4 a	6 a	3 a
ANOVA	----------------*p value*----------------			------------------*p value*----------------		
Cultivation	0.001	0.010	0.143	0.009	0.002	0.019
Herbicide	0.419	0.683	0.801	0.453	0.511	0.949
Cultivation * herbicide	0.118	0.534	0.950	0.170	0.667	0.985

[a] Means of a main effect within an environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

New waterhemp emergence control. Cultivation generally did not affect 'new waterhemp control' season-long at any environment (Table 6). Cultivation improved 'new waterhemp control' by 5% at Hickson-2018, 14 DAT, but had no effect 28 DAT. Cultivation improved 'new waterhemp control' by 4% at Renville-2017, 28 DAT, but had no effect 14 DAT. The differences were not considered season-long unless differences were seen at both evaluation dates because chloroacetamide herbicides have a 2 to 3 week effective period (Mueller et al. 1999). Cultivation did not affect 'new waterhemp control' at Nashua-2018. This occurrence is likely due to an interaction between sugarbeet stand density and the sugarbeet stage at which the treatments were applied. The treatments at Renville-2017 and Hickson-2018 were applied at the 8- to 10- and 6- to 8-leaf sugarbeet stages, respectively, while the treatments at Nashua-2018 were applied at the 4- to 6-leaf sugarbeet stage (Table 3). Sugarbeet density at Nashua-2018 was 65 sugarbeet per 100 ft row, while sugarbeet density at Renville-2017 and Hickson-2018 was 166 and 187 sugarbeet per 100 ft row, respectively (Table 4). The recommended sugarbeet density for optimal yield and weed suppression is 172 to 197 sugarbeet per 100 ft row (Cattanach 1994; Smith et al. 1990; M. Metzger 2018, personal communication). In an environment with a full and mature crop stand, cultivation would disrupt weed growth and allow the crop canopy to provide shade to suppress further weed emergence. While the crop canopy at Renville-2017 and Hickson-2018 were fuller and more mature than Nashua-2018, the differences were not sufficient to improve 'new waterhemp control' across both evaluation dates.

Residual herbicides applied with glyphosate generally improved 'new waterhemp control' relative to glyphosate alone in two of three environments (Table 6). Residual herbicides with glyphosate increased 'new waterhemp control' by 4 to 8% and Nashua-2018, 14 DAT and up to 13 to 15% at Renville-2017 and Nashua-2018, 28 DAT (Table 6). Herbicide treatment had no effect on 'new waterhemp control' at Renville-2017, 14 DAT or Hickson-2018 at any evaluation date. Herbicide treatment did not increase 'new waterhemp control' at Hickson-2018 at any evaluation date probably because the environment did not receive adequate precipitation until ten days after herbicide application. Chloroacetamide herbicides require 0.5 to 0.75 inches of precipitation to become activated into soil solution (Anonymous 2014, 2017). Chloroacetamide herbicides tended to provide numerically greater 'new waterhemp control' compared to Treflan and Ro-Neet, but statistical differences were not consistent. This is likely because chloroacetamide herbicides can be activated by rain alone, whereas Treflan and Ro-Neet require immediate soil-incorporation to become active.

Table 6. Effect of cultivation and herbicide on new waterhemp control at Renville-2017, Hickson-2018, and Nashua-2018, 14 and 28 days after treatment (DAT). [a]

	New waterhemp control, 14 DAT			New waterhemp control, 28 DAT		
Main effects	Renville	Hickson	Nashua	Renville	Hickson	Nashua
Cultivation	------------------%------------------			------------------%------------------		
With cultivation	89 a	100 a	97 a	91 a	96 a	95 a
No cultivation	91 a	95 b	96 a	87 b	96 a	93 a
Herbicide						
Glyphosate	83 a	97 a	91 b	81 c	97 a	83 c
Glyphosate + S-metolachlor	91 a	100 a	98 a	89 ab	99 a	96 ab
Glyphosate + Outlook	92 a	98 a	99 a	93 ab	100 a	98 a
Glyphosate + Warrant	88 a	100 a	99 a	94 a	98 a	98 a
Glyphosate + Treflan	92 a	98 a	95 ab	86 bc	94 a	89 bc
Glyphosate + Ro-Neet	94 a	94 a	99 a	92 ab	91 a	98 a
ANOVA	----------------*p value*----------------			------------------*p value*------------------		
Cultivation	0.082	0.009	0.328	0.006	0.867	0.423
Herbicide	0.061	0.150	0.004	0.011	0.066	0.004
Cultivation * herbicide	0.661	0.174	0.704	0.292	0.565	0.670

[a] Means within a main effect and environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

These results demonstrate the importance of mixing chloroacetamide herbicides with glyphosate to reduce the number of emerging waterhemp seedlings. Chloroacetamide herbicides in sugarbeet are applied in a 'layered' system where Dual Magnum is applied PRE and S-metolachlor, Outlook, or Warrant are tank mixed with glyphosate and applied twice POST to provide 'layered' residual control of small-seeded broadleaves until crop canopy closure (Peters et al. 2017). The use of this 'layered' system is important, as no herbicides currently labeled in sugarbeet provide season-long control of glyphosate-resistant waterhemp.

Sugarbeet producers have inquired if inter-row cultivation can be used to incorporate residual herbicides to improve their activity. Chloroacetamide herbicides need 0.5 to 0.75 inches of precipitation to become activated into soil solution (Anonymous 2014, 2017). In theory, cultivation could incorporate the herbicide into sub-surface soil moisture and activate the herbicide artificially in a dry season. Hickson-2018 received only 0.1 inches precipitation in the week following cultivation, while Renville-2017 and Nashua-2018 received over one inch. Cultivation did not enhance the activity of chloroacetamide herbicides at Hickson-2018 (Table 6) which had a dry period following herbicide application. More data is needed to form a reasonable conclusion, but this data suggests inter-row cultivation does not activate chloroacetamide herbicides and contribute to new waterhemp control in a dry season.

Overall waterhemp control. Cultivation improved 'overall waterhemp control' 6 to 12% across all environments and evaluation dates (Table 7). Data from 14 DAT and 28 DAT is representative of early to mid-season control, while data from 42 DAT is representative of season-long control. Cultivation increased 'overall waterhemp control' by 6% at Renville-2017, and 9 to 13% at Hickson-2018 and Nashua-2018, 42 DAT (Table 7). This data mirrors the waterhemp counts (Table 5) and new waterhemp control (Table 6) data since overall control is a visual summation of the previous two dependent variables. Cultivation significantly increased overall waterhemp control because it physically removed 50 to 75% of waterhemp plants 14 DAT (Table 5) and generally did not affect new waterhemp control. The primary benefit of cultivation is the physical removal of glyphosate resistant waterhemp with no apparent deleterious effects on future weed emergence.

Herbicide treatment did not affect 'overall waterhemp control' season-long at any environment (Table 7). Chloroacetamide herbicides with glyphosate tended to improve overall waterhemp control as compared to glyphosate alone, but no statistical difference was detected. Trifluralin (Treflan) and cycloate (RoNeet) provided similar overall waterhemp control compared to chloroacetamide herbicides. Differences were probably not detected in this data because glyphosate resistant waterhemp had already emerged in all environments at the time of treatment and soil-applied seedling inhibitor herbicides are ineffective for control of emerged waterhemp. Past research indicated mixing a chloroacetamide herbicide with glyphosate can improve season-long overall waterhemp control (Peters et al. 2017), but only if chloroacetamide herbicides are applied prior to waterhemp emergence.

Table 7. Effect of cultivation and herbicide on overall waterhemp control at Renville-2017, Hickson-2018, and Nashua-2018, 14, 28, and 42 days after treatment (DAT). [a]

	Overall control, 14 DAT			Overall control, 28 DAT			Overall control, 42 DAT		
Main effects	Renville	Hickson	Nashua	Renville	Hickson	Nashua	Renville	Hickson	Nashua
Cultivation	---------------%---------------			---------------%---------------			---------------%---------------		
With cultivation	93 a	97 a	96 a	91 a	93 a	90 a	84 a	91 a	83 a
No cultivation	85 b	91 b	88 b	83 b	85 b	83 a	78 b	79 b	72 b
Herbicide									
Glyphosate	87 a	95 a	88 a	83 a	89 a	81 a	78 a	84 a	71 a
Glyphosate + S-metolachlor	89 a	95 a	93 a	87 a	90 a	89 a	80 a	85 a	90 a
Glyphosate + Outlook	91 a	95 a	93 a	90 a	94 a	92 a	83 a	90 a	83 a
Glyphosate + Warrant	89 a	95 a	96 a	88 a	87 a	88 a	82 a	88 a	77 a
Glyphosate + Treflan	87 a	93 a	93 a	85 a	92 a	87 a	80 a	85 a	78 a
Glyphosate + Ro-Neet	92 a	90 a	90 a	90 a	83 a	83 a	81 a	76 a	67 a
ANOVA	------------*p value*------------			------------*p value*------------			------------*p value*------------		
Cultivation	0.002	0.004	0.006	0.011	0.004	0.058	0.008	0.002	0.041
Herbicide	0.452	0.752	0.676	0.344	0.624	0.778	0.864	0.517	0.243
Cultivation * herbicide	0.157	0.762	0.919	0.245	0.732	0.533	0.087	0.425	0.723

[a] Means within a main effect and environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

New common lambsquarters control and density. Cultivation improved 'new common lambsquarters control' by 8 to 9% at Wheaton-2017, 14 and 28 DAT (Tables 8 and 9). An interaction of cultivation by herbicide at 14 DAT at Wheaton-2017 demonstrates control with chloroacetamide herbicides generally was not improved with cultivation, but new common lambsquarters control with trifluralin and cycloate was improved with cultivation (Table 9). This result was expected because Treflan and Ro-Neet require immediate incorporation to provide effective control, while chloroacetamide herbicides are effective with timely precipitation alone. In contrast, cultivation decreased 'new common lambsquarters control' at 14 and 28 DAT by 10 to 15% at Galchutt-2018 (Table 8). Weed density data shows an increase in new common lambsquarters emergence from cultivation as cultivated treatments had nearly 100% more common lambsquarters per m^2 compared to non-cultivated treatments at Galchutt-2018, 28 DAT (Table 10).

The difference in 'new common lambsquarters control' from cultivation between Wheaton-2017 and Galchutt-2018 was likely due to site differences in sugarbeet density, date of application, and the sugarbeet stage at which the treatments were applied. Sugarbeet density at Wheaton-2017 was full and uniform with 194 sugarbeet per 100 ft row, while sugarbeet density at Galchutt-2018 was non-uniform and with 158 sugarbeet per 100 ft row (Table 4). Treatments were applied to 8- to 10-leaf sugarbeet at Wheaton-2017 and 4- to 6-leaf sugarbeet at Galchutt-2018 (Table 3). This difference in crop maturity between environments likely affected the role of canopy coverage on new common lambsquarters control. Based on calendar date, Galchutt-2018 was treated 18 days before Wheaton-2017 (Table 3). A cultivation/herbicide treatment later in the season would most likely have had less lambsquarters emergence following cultivation because common lambsquarters is an early emerging, C3, summer annual weed. An early cultivation with little canopy coverage would also have exposed the tilled seeds to light. Buhler (1997) reported common lambsquarters emergence increased nearly 250% when tillage was performed in the light compared to the dark. This implies producers should avoid cultivation until the crop canopy can provide shade to reduce the stimulation of common lambsquarters emergence.

Residual herbicides applied with glyphosate improved 'new common lambsquarters control' compared to glyphosate alone in one of two environments (Tables 8 and 9). Chloroacetamide herbicides provided greater 'new common lambsquarters control' compared to glyphosate alone and glyphosate plus Treflan or Ro-Neet at Wheaton-2017, 14 DAT (Table 9), but no difference was detected 28 DAT (Table 8). Residual herbicides applied with glyphosate gave significantly greater control of emerging lambsquarters compared to glyphosate alone in terms of both visible control and density measurements at Galchutt-2018, 14 and 28 DAT (Tables 8 and 10). Common lambsquarters likely responded differently to herbicide treatments at Wheaton-2017 and Galchutt-2018 due to differences in crop stage at time of treatment. Herbicide treatments were applied to 8- to 10-leaf sugarbeet at Wheaton in 2017 compared to 4- to 6-leaf sugarbeet at Galchutt in 2018 (Table 3). Crop canopy at Wheaton-2017 likely provided shade and suppressed weed emergence, reducing the effect of herbicide treatment.

Table 8. Effect of cultivation and herbicide on new common lambsquarters control at Wheaton-2017 and Galchutt-2017, 14 and 28 days after treatment (DAT). [a]

	New common lambsquarters control, 14 DAT	New common lambsquarters control, 28 DAT	
Main effects	Galchutt	Wheaton	Galchutt
Cultivation	--%--	-------------%-------------	
With cultivation	80 b	91 a	65 b
No cultivation	90 a	83 b	80 a
Herbicide			
Glyphosate	70 b	87 ab	47 b
Glyphosate + S-metolachlor	89 a	89 ab	80 a
Glyphosate + Outlook	90 a	90 a	82 a
Glyphosate + Warrant	87 a	92 a	75 a
Glyphosate + Treflan	85 a	80 b	70 a
Glyphosate + Ro-Neet	90 a	81 ab	81 a
ANOVA	*-p value-*	-----------*p value*-----------	
Cultivation	0.003	0.007	0.001
Herbicide	< 0.001	0.010	< 0.001
Cultivation * herbicide	0.320	0.223	0.132

[a] Means within a main effect and environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

Table 9. Interaction of cultivation by herbicide on new common lambsquarters control at Wheaton-2017, 14 days after treatment (DAT). [a]

	New common lambsquarters control, 14 DAT
Cultivation * herbicide interaction	Wheaton
With cultivation	--%--
Glyphosate	92 ab
Glyphosate + S-metolachlor	92 ab
Glyphosate + Outlook	93 a
Glyphosate + Warrant	94 a
Glyphosate + Treflan	92 ab
Glyphosate + Ro-Neet	92 ab
No cultivation	
Glyphosate	83 cd
Glyphosate + S-metolachlor	90 ab
Glyphosate + Outlook	90 ab
Glyphosate + Warrant	87 bc
Glyphosate + Treflan	76 de
Glyphosate + Ro-Neet	69 e
ANOVA	*-p value-*
Cultivation	0.002
Herbicide	0.084
Cultivation * herbicide	0.010

[a] Means not sharing any letter are significantly different by the t-test at the 5% level of significance.

Table 10. Effect of cultivation and herbicide on common lambsquarters density at Galchutt-2017, 14 and 28 days after treatment (DAT). [a]

	Common lambsquarters density, 14 DAT	Common lambsquarters density, 28 DAT
Main effects	Galchutt	Galchutt
Cultivation	# per m^2	# per m^2
With cultivation	20 a	48 a
No cultivation	18 a	25 b
Herbicide		
Glyphosate	25 a	80 b
Glyphosate + S-metolachlor	12 a	34 a
Glyphosate + Outlook	14 a	32 a
Glyphosate + Warrant	13 a	28 a
Glyphosate + Treflan	27 a	24 a
Glyphosate + Ro-Neet	20 a	20 a
ANOVA	*-p value-*	*-p value-*
Cultivation	0.217	0.018
Herbicide	0.098	< 0.001
Cultivation * herbicide	0.620	0.099

[a] Means within a main effect and evaluation date column not sharing any letter are significantly different by the t-test at the 5% level of significance.

[b] Cultivation treatments were cultivated immediately after spray treatment.

[c] All herbicide treatments included ethofumesate, high surfactant methylated oil concentrate, and liquid ammonium sulfate solution.

Overall common lambsquarters control. Season-long 'overall common lambsquarters control' was the same in cultivation and herbicide treatments across environment and evaluation date (Table 11). Overall lambsquarters control tended to be greater from cultivation compared to no cultivation at 42 DAT at Wheaton-2017, but the differences were not statistically significant (P = 0.069). Overall lambsquarters control tended to be less from cultivation compared to no cultivation at 42 DAT at Galchutt-2018, but the differences were not statistically significant (P = 0.127). Overall control was a visual summation of new emergence and old growth control, so this data is consistent with new emergence control and weed density data where cultivation reduced new common lambsquarters control and increased weed density 28 DAT at Galchutt-2018 (Table 9). Herbicide treatments did not provide satisfactory season-long overall common lambsquarters control at either environment (Table 11). There was a numerical trend at Galchutt-2018 for residual herbicides with glyphosate providing 11 to 27% greater control 42 DAT, but this difference was not statistically significant (P = 0.085). This trend was not present at Wheaton-2017 where glyphosate alone gave similar overall control compared to glyphosate mixed with a residual herbicide (Table 11).

Table 11. Effect of cultivation and herbicide on overall common lambsquarters control at Wheaton-2017 and Galchutt-2018, 14, 28, and 42 days after treatment (DAT). [a]

	Overall control, 14 DAT		Overall control, 28 DAT		Overall control, 42 DAT	
Main effects	Wheaton	Galchutt	Wheaton	Galchutt	Wheaton	Galchutt
Cultivation	----------%----------		----------%----------		----------%----------	
With cultivation	98 a	100 a	96 a	83 a	78 a	73 a
No cultivation	96 a	100 a	94 a	87 a	70 a	80 a
Herbicide						
Glyphosate	99 a	100 a	99 a	77 a	73 a	60 a
Glyphosate + S-metolachlor	99 a	99 a	98 a	88 a	77 a	80 a
Glyphosate + Outlook	97 a	100 a	97 a	88 a	86 a	87 a
Glyphosate + Warrant	98 a	100 a	96 a	89 a	77 a	81 a
Glyphosate + Treflan	93 a	100 a	89 a	82 a	68 a	71 a
Glyphosate + Ro-Neet	95 a	100 a	90 a	86 a	66 a	81 a
ANOVA	-------*p value*-------		-------*p value*-------		-------*p value*-------	
Cultivation	0.363	0.363	0.446	0.158	0.069	0.127
Herbicide	0.438	0.438	0.057	0.229	0.162	0.085
Cultivation * herbicide	0.438	0.438	0.467	0.114	0.645	0.902

[a] Means within a main effect and environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

Conclusion: Should I cultivate immediately after herbicide application?

Cultivation immediately after herbicide application can improve overall waterhemp control because it physically removes waterhemp that glyphosate will not control. The cultivator removed 50 to 75% of herbicide resistant waterhemp, which resulted in 6 to 12% greater waterhemp control at the end of the season compared to not using a cultivator (Tables 5 and 7). Sugarbeet producers have asked if cultivation can be used to activate chloroacetamide herbicides in a dry year. Hickson-2018 was the only environment without activating precipitation in the ten days following herbicide treatment and 'new waterhemp control' was not enhanced with cultivation in that environment (Table 6). Further research is needed to strengthen this conclusion, but these data suggest that chloroacetamide activation cannot be achieved with a cultivator in a dry environment. Cultivation after herbicide application reduced common lambsquarters control at Galchutt-2018 compared to herbicide treatments without cultivation (Table 8). This is most likely due to insufficient sugarbeet canopy at time of cultivation to adequately shade the soil surface and suppress further common lambsquarters emergence. Cultivation provides a means of removing glyphosate resistant weeds from sugarbeet, but does not improve weed control compared to glyphosate application when weeds are susceptible to glyphosate.

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DELAYED CULTIVATION TO SUPPLEMENT CHLOROACETAMIDE HERBICIDES IN SUGARBEET

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Summary

Sugarbeet producers have asked if cultivation a few weeks after applying chloroacetamide herbicides can remove glyphosate-resistant waterhemp without reducing the efficacy of their layby herbicides and without stimulating another flush of weeds. Field trials were conducted to evaluate the effectiveness of delayed cultivation and how cultivation affects weed emergence. Cultivation can remove 65% of herbicide-resistant waterhemp and have no effect on waterhemp emergence if timed at canopy closure. A repeat glyphosate application is cost effective and more reliable than cultivation to control common lambsquarters.

Introduction and Objectives

Many sugarbeet producers in 2018 applied glyphosate and chloroacetamide herbicides in layers until crop canopy closure. Inter-row cultivators are often used a few weeks after spraying to remove herbicide-resistant weed "escapes". Producers would like to know if inter-row cultivation is a viable tool to remove weeds that glyphosate did not control. Producers would also like to know how a delayed inter-row cultivation affects weed emergence and how it interacts with already-present chloroacetamide herbicides. Therefore, the objectives of this experiment were to 1) evaluate the effectiveness of cultivation at removing herbicide-resistant weeds in sugarbeet and 2) evaluate how delayed cultivation affects weed emergence.

Materials and Methods

Site Description. Field experiments were conducted at two locations in eastern North Dakota and Minnesota in 2017 and at two locations in 2018. Each site-year combination is considered an environment. Environments in 2017 were near Wheaton, MN (45°47'11.0"N, 96°21'15.4"W) and Renville, MN (44°47'07.5"N, 95°08'20.2"W). Environments in 2018 were near Galchutt, ND (46°21'31.7"N, 96°50'22.7"W), and Nashua, MN (46°02'43.2"N, 96°19'38.5"W). Excessive precipitation destroyed two of six replications for the last two evaluations at the Wheaton-2017 environment. Soil descriptions for each used environment can be found in Table 1. The dominant weed at the Renville-2017 and Nashua-2018 environments was waterhemp and the dominant weed at the Wheaton-2017 and Galchutt-2018 environments was common lambsquarters. The four environments were separated into two groups: waterhemp and common lambsquarters.

Table 1. Soil descriptions across environments in 2017 and 2018.

Environment	Soil series & texture	Organic Matter	Soil pH
Wheaton-2017	Doran & Mustinka loam mix	5.1%	6.9
Renville-2017	Mayer silty clay loam	7.7%	7.9
Galchutt-2018	Wyndmere loam	5.0%	7.5
Nashua-2018	Croke sandy loam	3.5%	7.2

Experimental Procedures. The experiment was a 2x4 factorial split-block arrangement in a randomized complete block design with four to six replications depending on environment. Each replication (block) was two factors, cultivation and herbicide treatment. Untreated plots were included for comparison. Sugarbeet was planted on May 15, 2017 at Renville, May 8, 2017 at Wheaton, May 14, 2018 at Nashua, and May 14, 2018 at Galchutt to a density of 61,000 (+/- 1,000) seeds per acre in plots that were 11 feet wide (six rows spaced 22-inches apart) and 30 feet long. S-metolachlor (Dual Magnum, Syngenta Crop Protection) at 0.5 pts/A was applied preemergence (PRE) within 48 hours after planting across the entire trial area in all environments to minimize the effects of early season weed competition.

Herbicide treatments were applied to 3- to 4-inch weeds with a bicycle wheel-type sprayer with a shielded boom to reduce particle drift at a volume of 17 gal/A. The center four rows of each six-row plot were sprayed using pressurized CO_2 at 35 PSI through 8002XR nozzles (TeeJet Technologies, Glendale Heights, IL). Half of the treatments were cultivated approximately two weeks after herbicide application using a modified Alloway 3130 cultivator (Alloway Standard Industries, Fargo, ND) with 15-inch sweep shovels spaced at 22 inches with a ground depth of 1.5 to 2 inches at 4 MPH. Information and use rates of herbicide can be found in Table 2. Dates of planting, herbicide application, cultivation, and crop stage at herbicide application can be found in Table 3.

Table 2. Herbicide product information for treatments applied to 3- to 4-inch weeds.

Herbicide [a]	Product Rate	Trade name	Manufacturer [b]
	fl oz/A		
Glyphosate	28	Roundup PowerMAX	Monsanto
Glyphosate + S-metolachlor	28 + 20	Roundup PowerMAX + Dual Magnum	Monsanto + Syngenta
Glyphosate + dimethenamid-P	28 + 18	Roundup PowerMAX + Outlook	Monsanto + BASF
Glyphosate + acetochlor	28 + 52	Roundup PowerMAX + Warrant	Monsanto

[a] Adjuvants: All treatments included ethofumesate at 4 oz/A (Ethofumesate 4SC, Willowood LLC), high surfactant methylated oil concentrate at 1.5 pt/A (Destiny HC, Winfield Solutions LLC), and ammonium sulfate liquid solution at 2.5% v/v (N-Pak AMS liquid, Winfield Solutions LLC).
[b] Manufacturer information: Monsanto Company, St. Louis, MO; Syngenta Crop Protection, Greensboro, NC; BASF Corporation, Research Triangle Park, NC.

Table 3. Planting dates, herbicide application dates, cultivation dates, and crop stage of sugarbeet at environments in 2017 and 2018.

Environment	Planting date	Application date		Cultivation date	SGBT stage at POST
		PRE [a]	POST		
Renville, MN-2017	May 15	May 15	June 26	July 10	8-10 leaf
Wheaton, MN-2018	May 8	May 9	June 27	July 14	8-10 leaf
Nashua, MN-2018	May 14	May 15	June 12	June 26	6-8 leaf
Galchutt, ND-2018	May 14	May 15	June 21	July 5	6-8 leaf

[a] Abbreviations: PRE = preemergence; POST = postemergence; SGBT = sugarbeet.

Data Collection and Analysis. Percent weed control was evaluated as 'overall control' and 'new weed emergence control' at 14, 28, and 42 (+/- 3) days after the cultivation treatment (DAC). Evaluations were a scale of 0% (no control) to 100% (complete control) relative to the untreated check rows between treatments. 'New weed emergence control' evaluated weeds that emerged since the last treatment, while 'overall control' evaluated old and new growth. Waterhemp in the 7-foot by 30-foot treated area of each 11-foot by 30-foot plot were counted 14 and 28 DAC at the Renville-2017 and Nashua-2018 environments. Waterhemp plants counted were considered glyphosate resistant because only plants that had emerged prior to herbicide application were counted and all treatments included glyphosate. Seedlings were evaluated as part of 'new weed emergence control'. Sugarbeet density was determined by counting emerged sugarbeet in treated rows.

Statistical analysis was conducted using SAS 9.4 (SAS Institute, Cary, NC). Data was subjected to ANOVA using PROC MIXED to test for treatment differences and significant interactions. Data was analyzed as a split-block design with expected means squares recommended by Carmer et al. (1989). Significantly different treatment means were separated using t-tests when data was found to be significantly different at the $P \leq 0.05$. The cultivation and herbicide treatment factors were considered fixed effects, while replicate and environment were considered random effects. All environments were analyzed separately because of differences in primary weed species, precipitation, sugarbeet density, and sugarbeet stage at which the treatments were applied. Only main effects are presented when no significant cultivation by herbicide interaction was detected.

Results and Discussion

Field Growing Conditions. Precipitation in the weeks following planting in 2017 was close to the 30-year average, but 2018 was relatively dry. Stand establishment was one of the greatest production challenges for sugarbeet producers in 2018 because of this dry period immediately after planting. Sugarbeet density at Renville-2017, Wheaton-2017, and Galchutt-2018 was near the optimal range of 175 to 200 sugarbeet per 100 ft row (Cattanach 1994; Smith et al. 1990; M. Metzger 2018, personal communication), but sugarbeet density at Nashua-2018 was 50% of the recommended density (Table 4). Crop density is an important component of sugarbeet weed management (Dawson 1977) and the poor sugarbeet density at Nashua-2018 and Galchutt-2018 likely reduced the contribution of crop canopy on weed suppression.

Table 4. Primary weed species present and sugarbeet density across environments in 2017 and 2018.

Environment	Primary weed species	Sugarbeet density [a]
		# per 100 ft row
Renville-2017	Waterhemp	180
Wheaton-2017	Common lambsquarters	193
Nashua-2018	Waterhemp	85
Galchutt-2018	Common lambsquarters	162

[a] Sugarbeet density is number of sugarbeets per 100 ft of row.

Waterhemp density per plot. Delayed cultivation reduced the number of waterhemp plants per plot in one of two environments (Table 5). At Renville-2017, cultivation removed nearly 65% of the waterhemp plants from the cultivated plots when accessed 14 DAC. At Nashua-2018, cultivation numerically reduced waterhemp per plot by one third; however, waterhemp densities were as low as 2 to 3 plants per plot and were insufficient to detect a statistical difference (P = 0.119). Had waterhemp densities at Nashua-2018 been greater and more uniform, a 65 to 70% reduction in waterhemp plants per plot between cultivated and no cultivated plots would be expected. This is because the cultivator was equipped with 15-inch wide shovels and covered approximately 68% of the field surface area (sugarbeet were grown in 22-inch rows) to remove emerged weeds.

Waterhemp density was not affected by herbicide treatment at either location. (Table 5). Herbicide treatments were applied to actively growing waterhemp. Since chloroacetamide herbicides have no efficacy on emerged waterhemp, glyphosate was the only herbicide in the treatment that could have had efficacy (POST) on emerged plants. The glyphosate alone treatment had the least waterhemp density per plot, numerically, at both environments. This observation suggests antagonism between herbicide mixtures; however, past research does not indicate significant antagonism between chloroacetamide herbicides and glyphosate exists (Tharp and Kells 2002).

New waterhemp emergence control. Cultivation did not affect 'new waterhemp control' at Nashua-2018 but improved 'new waterhemp control' by 11% at Renville-2017 (Table 5). Only data from 14 DAC was reported for 'new waterhemp control' because chloroacetamide herbicides have an effective period of 2 to 3 weeks (Mueller et al. 1999), and 14 DAC was 28 days after spray application. Waterhemp control similar in cultivated and no-cultivated plots might be attributed to the timing of the cultivation. Cultivation disrupted the emerging growth of new weeds between the rows and crop canopy created shade, suppressing any further emergence when cultivation was timed near crop canopy closure. In addition, waterhemp emergence is triggered by changes in moisture and temperature near the soil surface. Oryokot et al. (1997) reported soil disturbance, for example, soil disturbance caused by inter-row cultivation, does not affect moisture or air temperature in the zone where *Amaranthus* species seeds germinate and emerge.

Cultivation likely reduced weed emergence at Renville-2017 due to an interaction between precipitation after the cultivation and the sugarbeet density in each environment. Nashua-2018 received over one inch of precipitation in the two weeks following cultivation while Renville-2017 received less than a half inch. Cultivation at Renville-2017 may have disrupted new weed growth and conditions between the time of cultivation and canopy closure were not conducive for further weed emergence. Conditions were conducive for weed growth at

Table 5. Effect of cultivation and herbicide on waterhemp density and new waterhemp control at Renville, MN-2017 and Nashua, MN-2018, 14 and 28 days after cultivation treatment (DAC). [a]

	Waterhemp counts, 14 DAC		Waterhemp counts, 28 DAC		New waterhemp control, 14 DAC	
Main effects	Renville	Nashua	Renville	Nashua	Renville	Nashua
Cultivation	-----# per plot-----		----# per plot----		----------%----------	
With cultivation	7 a	2 a	9 a	2 a	100 a	98 a
No cultivation	19 b	3 a	20 b	3 a	89 b	98 a
Herbicide						
Glyphosate	8 a	1 a	9 a	1 a	90 b	92 b
Glyphosate + S-metolachlor	21 a	2 a	23 a	2 a	95 a	100 a
Glyphosate + Outlook	9 a	3 a	11 a	4 a	97 a	100 a
Glyphosate + Warrant	15 a	3 a	16 a	3 a	95 a	100 a
ANOVA	--------*p value*--------		--------*p value*--------		--------*p value*-------	
Cultivation	0.013	0.379	0.026	0.119	0.007	1.000
Herbicide	0.062	0.739	0.069	0.576	0.028	0.022
Cultivation*herbicide	0.535	0.108	0.676	0.801	0.282	0.515

[a] Means of a main effect within an environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

Nashua-2018, regardless of cultivation. In addition, sugarbeet density at Nashua-2018 was 85 sugarbeet per 100 ft row, or half an optimal density (Table 4). Sugarbeet density at Renville-2017, meanwhile, was quite uniform at 180 sugarbeet per 100 ft row. This difference in density between the two environments would have affected the role of crop canopy on weed suppression, which is a crucial component of weed management in sugarbeet (Dawson 1977).

Chloroacetamide herbicides with glyphosate increased control of newly emerging waterhemp by 5 to 8% compared to glyphosate alone at both environments (Table 5. Chloroacetamide herbicides gave similar waterhemp control at both environments. This result was expected since chloroacetamide herbicides in sugarbeet provide residual control of emerging small-seeded broadleaf weeds. These results demonstrate the value of mixing chloroacetamide herbicides with glyphosate to reduce the number of emerging waterhemp seedlings. Chloroacetamide herbicides in sugarbeet can be applied in a 'layered' system where Dual Magnum is applied PRE and S-metolachlor, Outlook, or Warrant are tank mixed with glyphosate and applied up to twice POST to provide "layered" residual control of small-seeded broadleaves until crop canopy closure (Peters et al. 2017). The use of this 'layered' system is important component in providing season-long control of glyphosate resistant waterhemp.

Overall waterhemp control. Cultivation improved season-long 'overall waterhemp control' at Renville-2017 but did not affect season-long waterhemp control at Nashua-2018 (Table 6). Data from 14 DAC and 28 DAC is representative of early to mid-season control, while data from 42 DAC is representative of season-long control. Cultivation significantly increased waterhemp control 15 to 20% at 42 DAC at Renville-2017 but did not significantly affect waterhemp control at Nashua-2017 (Table 6). These results are similar to the waterhemp density results (Table 5) and new waterhemp control data (Table 5) previously described.

'Overall waterhemp control' was not affected by herbicide treatment at Nashua, but S-metolachlor plus glyphosate provided less season-long waterhemp control than other herbicides at Renville-2017 (Table 6). S-metolachlor plus glyphosate had less overall control at Renville-2017 because of coincidentally greater numbers of herbicide-resistant weeds in plots, as new weed emergence control was not different compared with other chloroacetamide herbicides (Table 5). Counted plants were considered glyphosate resistant because only plants emerged prior to herbicide application were counted. Numerically, there were 21 waterhemp plants per plot in the S-metolachlor with glyphosate treatment compared with eight waterhemp per glyphosate alone treatment, but the difference was not statistically significant (Table 5). This observation would imply antagonism between glyphosate and S-metolachlor, but past research does not indicate antagonism exists (Tharp and Kells 2002).

Table 6. Effect of cultivation and herbicide on overall waterhemp control at Renville-2017 and Nashua-2018, 14, 28, and 42 days after cultivation treatment (DAC). [a]

Main effects	Overall control, 14 DAC		Overall control, 28 DAC		Overall control, 42 DAC	
	Renville	Nashua	Renville	Nashua	Renville	Nashua
Cultivation	----------%----------		----------%----------		----------%----------	
With cultivation	86 a	91 a	80 a	88 a	76 a	87 a
No cultivation	71 b	89 a	63 b	82 a	57 b	82 a
Herbicide						
Glyphosate	83 a	88 a	77 a	86 a	74 a	84 a
Glyphosate + S-metolachlor	70 b	90 a	61 b	85 a	58 b	86 a
Glyphosate + Outlook	83 a	88 a	77 a	81 a	73 a	80 a
Glyphosate + Warrant	80 a	91 a	71 a	88 a	67 a	88 a
ANOVA	--------*p value*--------		--------*p value*--------		---------*p value*---------	
Cultivation	< 0.001	0.252	0.001	0.115	0.001	0.245
Herbicide	0.005	0.893	0.005	0.836	0.002	0.788
Cultivation*herbicide	0.915	0.134	0.744	0.524	0.716	0.144

[a] Means of a main effect within an environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

<u>New common lambsquarters control.</u> Cultivation improved 'new common lambsquarters control' at Wheaton-2017 but did not improve lambsquarters control at Galchutt-2018 (Table 7). Sugarbeet density and sugarbeet stage at application is likely the reason for this difference. Herbicide was applied to 8- to 10-leaf sugarbeet at Wheaton-2017 and 6- to 8-leaf sugarbeet at Galchutt-2018 (Table 3). Wheaton-2017 had a full and uniform density of 193 sugarbeet per 100 ft row, while the density at Galchutt-2018 was less than optimal at 162 sugarbeet per 100 ft row (Table 4). Sugarbeet density at Galchutt-2018 was also noted to be non-uniform with frequent and random gaps. The smaller and less dense/uniform sugarbeet stand at Galchutt-2018 would have reduced the contribution of canopy closure on weed emergence. At Wheaton-2017, cultivation disrupted weed growth and allowed the sugarbeet canopy to suppress further emergence, but the gaps in stand and canopy at Galchutt-2018 at the time of treatment created conditions conducive for further weed growth after the cultivation. This would imply

Table 7. Effect of cultivation and herbicide on new common lambsquarters control at Wheaton-2017 and Galchutt-2018, 14 days after cultivation treatment (DAC). [a]

Main effects	New common lambsquarters control, 14 DAC	
	Wheaton	Galchutt
Cultivation	------------------%------------------	
With cultivation	92 a	97 a
No cultivation	77 b	94 a
Herbicide		
Glyphosate	76 b	89 a
Glyphosate + S-metolachlor	87 a	98 a
Glyphosate + Outlook	92 a	98 a
Glyphosate + Warrant	82 ab	98 a
ANOVA	----------------*p value*----------------	
Cultivation	0.027	0.220
Herbicide	0.032	0.160
Cultivation * herbicide	0.991	0.106

[a] Means of a main effect within an environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

the optimal time to cultivate is mid-July or near canopy closure when a healthy crop canopy can provide shade and suppress further weed emergence.

Overall common lambsquarters control. 'Overall common lambsquarters control' was not affected by cultivation in neither environment (Tables 8 and 9). An increase of 10% lambsquarters control was observed 14 DAC at Wheaton-2017, but no statistical difference was observed 42 DAC due to variability. Overall common lambsquarters control was 7 to 19% greater from cultivation at 42 DAC compared to no cultivation (Table 8), but no statistical difference occurred at either environment.

Table 8. Effect of cultivation and herbicide on overall common lambsquarters control at Wheaton-2017 and Galchutt-2018, 14, 28, and 42 days after cultivation treatment (DAC). [a]

	Overall control, 14 DAC		Overall control, 28 DAC	Overall control, 42 DAC	
Main effects	Wheaton	Galchutt	Wheaton	Wheaton	Galchutt
Cultivation	----------%----------		--%--	----------%----------	
With cultivation	95 a	99 a	96 a	92 a	94 a
No cultivation	85 b	96 a	81 a	73 a	87 a
Herbicide					
Glyphosate	83 a	95 a	92 a	87 a	83 a
Glyphosate + S-metolachlor	91 a	97 a	81 a	78 a	92 a
Glyphosate + Outlook	95 a	100 a	89 a	85 a	95 a
Glyphosate + Warrant	91 a	99 a	91 a	80 a	92 a
ANOVA	-------*p value*-------		-*p value*-	-------*p value*-------	
Cultivation	0.046	0.058	0.108	0.060	0.060
Herbicide	0.110	0.106	0.393	0.504	0.055
Cultivation * herbicide	0.927	0.134	0.478	0.389	0.108

[a] Means of a main effect within an environment column not sharing any letter are significantly different by the t-test at the 5% level of significance.

Table 9. Interaction of cultivation by herbicide on overall common lambsquarters control at Galchutt-2018, 28 days after cultivation treatment (DAC). [a]

	Overall lambsquarters control, 28 DAC
Cultivation * herbicide interaction	Galchutt
With cultivation	--%--
Glyphosate	88 b
Glyphosate + S-metolachlor	92 ab
Glyphosate + Outlook	100 a
Glyphosate + Warrant	98 a
No cultivation	
Glyphosate	72 c
Glyphosate + S-metolachlor	93 ab
Glyphosate + Outlook	93 ab
Glyphosate + Warrant	98 a
ANOVA	-*p value*-
Cultivation	0.067
Herbicide	0.013
Cultivation * herbicide	0.042

[a] Means not sharing any letter are significantly different by the t-test at the 5% level of significance.

'Overall common lambsquarters control' did not improved with chloroacetamide herbicides plus glyphosate compared to glyphosate alone (Tables 8 and 9). An interaction between cultivation and herbicide 28 DAC at Galchutt-2018 indicated lambsquarters control from glyphosate alone increased 16% by cultivation (Table 9). This interaction demonstrates cultivation benefitted glyphosate but cultivation was not necessary when glyphosate was combined with residual herbicides. Cultivation and tank-mixing a chloroacetamide herbicide with glyphosate are probably not necessary to manage common lambsquarters, as glyphosate provides excellent common lambsquarters control alone (Sivesend et al. 2011). A repeat glyphosate application probably is more effective than cultivation.

Conclusion: Should I follow herbicide application with a delayed cultivation pass?

Inter-row cultivation two weeks after herbicide application improved overall waterhemp control because it physically removed glyphosate resistant waterhemp. The cultivator removed 65% of herbicide-resistant waterhemp, which translated to 20% greater season-long overall control at Renville-2017 (Tables 5 and 6). At Nashua-2018, no benefit from cultivation was observed because of low waterhemp densities and thin/non-uniform sugarbeet densities. Many producers have asked if cultivation is a viable option to control herbicide-resistant waterhemp escapes without disrupting an activated herbicide barrier. This data suggests cultivation will effectively remove two thirds of weed escapes with no apparent deleterious effects. Cultivation timed two weeks after residual herbicide application or near canopy closure will disrupt weed growth and allow the crop canopy to suppress further emergence. Delayed cultivation is not necessary to control glyphosate-susceptible common lambsquarters because a repeat glyphosate application is cost effective and usually provides near 100% common lambsquarters control.

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SUGARBEET TOLERANCE AND ROTATIONAL CROP SAFETY FROM ETHOFUMESATE 4SC APPLIED POSTEMERGENCE

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Summary

1. Minimal to no visual sugarbeet injury was observed throughout the 2017 growing season. Sugarbeet growth, root yield, percent sucrose, and recoverable sucrose were not affected by ethofumesate or timing of ethofumesate application.
2. No adverse effects were observed throughout the 2018 growing season to rotational crop stand establishment or plant development from any treatment. Minimal to no visual crop injury was observed across all locations.
3. Environmental factors, such as weather, had a negative impact on yield at certain locations.
4. At Richville, MI, reduced grain moisture at harvest was observed in corn when ethofumesate was applied July 15 or later the previous growing season.

Introduction

Crop diversity is essential when practicing sustainable agriculture. Diversifying crop sequences introduces multiple growth cycles to a single field and aids in reducing inputs, such as pesticides, nutrients, etc. (Liebman and Dyck 1993). Decreased weed pressure is also a result of crop rotations, as well as increased crop yield (Peterson and Varvel 1989). Rotational benefits are evident when practicing a grass-legume rotation. In the Red River Valley, common rotational practices include alternating shallow and deep-rooted crops, as well as incorporating grain crops and legume crops (Tanner 1948). Sugarbeet is a deep-rooted crop grown in the Red River Valley. Herbicide residues from the previous growing season can potentially injure sensitive plants within the crop rotation (Sheets and Harris 1965). Ethofumesate is a herbicide labeled in sugarbeet for controlling grass and small-seeded broadleaf weeds (Peters and Lystad 2017) with historical reports of rotational crop injury (Schroeder and Dexter 1978). Willowood USA, a company that produces generic crop protection products for the agriculture industry, such as 'Ethofumesate 4SC', has increased the maximum label rates for post-emergence use in sugarbeet from 0.8 to 8 pt/A, along with decreasing the Pre-Harvest Interval (PHI) from 90 to 45 days.

The objective of this study was to evaluate crop safety from Ethofumesate 4SC at rates greater than 12 fl oz/A (0.8 pt/A) applied post-emergence in Roundup Ready (RR) sugarbeet in 2017 and the carry-over effects in wheat, corn, soybean, and dry bean in 2018.

Materials and Methods

Experiments were conducted near Crookston, Foxhome, and Lake Lillian, MN, Prosper, ND, and Richville, MI in 2017 and 2018. In 2017, the experimental area was prepared for planting by applying the appropriate fertilizer and tillage to each location. Sugarbeet was strategically planted at each location between the end of April and the beginning of May to achieve 9, 10, and 11-month crop rotation intervals in 2018 following ethofumesate treatment applications in 2017. Sugarbeet varieties included "SV36271RR", "BT80RR52", "HM4062", "BT9230", and "HM9619RR" at Prosper, ND, Crookston, MN, Foxhome, MN, Lake Lillian, MN, and Richville, MI, respectively.

Herbicide treatments included applications of ethofumesate at multiple rates and timings throughout the summer as well as an untreated control (Table 1). Applications made in June, July, and August simulated 11, 10, and 9-month crop rotation intervals, respectively. Applications at Prosper, ND were made with a bicycle sprayer early in the season and a backpack sprayer later in the season in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 40 psi to all 6 rows of the 6-row plots 40 feet in length in each of 3 experimental areas. High-surfactant methylated oil concentrate (HSMOC) used in all treatments across all locations was a liquid formulation from Winfield United called 'Destiny HC'. Weeds, insects, and diseases were managed throughout the growing season.

Table 1. Treatment list in 2017.

Number	Treatment	Rate (fl oz)	Timing of application
1	Untreated control	0	
2	Etho[1]/etho/etho/etho	32/32/32/32	A=2-lf stage/ B=A+14 days / C=B+ 14 days / D=C+14 days
3	Ethofumesate	128	E=June 15
4	Ethofumesate	128	F=July 15
5	Ethofumesate	128	G=August 15

[1]Ethofumesate

Sugarbeet injury was a visual estimate of percent growth reduction of all 6 rows per plot. Sugarbeet was harvested from the experimental area in the fall and assessed for yield and quality. Sugarbeet that were not collected for yield assessment were removed from the experimental area to simulate harvest similar to a commercial field setting. 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.

Plots were prepared in the spring using a field cultivator. Tillage was applied in the same direction as the previous herbicide treatments to prepare the seed bed and incorporate recommended fertilizer for each crop. "DKC45-64RR2" corn, "AG0934RR2" soybean, and "Prosper" wheat was planted into three different experimental areas with planting rates of 31,000 seeds per acre, 150,000 seeds per acre, and 163 pounds per acre, respectively at Crookston, MN, Prosper, ND, Foxhome, MN, and Lake Lillian, MN. Crop varieties planted at Richville, MI were "Stine 9316" corn, "Stine 14RD16" soybean, and "Zenith" dry bean with planting rates of 32,000, 150,000, and 106,000 seeds per acre, respectively. Weeds, insects, and disease were managed throughout the 2018 growing season.

Crop injury was evaluated on May 29, June 9, and June 20, 2018 at Prosper; June 5, June 14, June 25, and July 9, 2018 at Crookston; May 31, June 14, and July 12, 2018 at Lake Lillian; and May 31, June 15, June 29, July 16, and August 14 at Richville, MI. All evaluations were a visual estimate of percent fresh weight reduction in the six treated rows compared to the untreated control. Stand was collected at the same time as the first visual injury evaluations by counting the first 10 feet of the middle two rows in each plot. The first 30 feet of each plot was counted in Richville, MI. Plant height was collected at the same time as the last visual injury evaluation by averaging multiple measurements recorded throughout the plot. Data were analyzed as previously described.

Results and Discussion

Sugarbeet Results:

Visual sugarbeet injury was negligible at any location throughout the growing season. Yield data were combined across locations (Table 2). No differences were observed across all locations. The average root yield, extractable sucrose, and percent sugar across locations were 28.5 ton/A, 8,499 pounds per acre (lb/A), and 16.6%, respectively.

Table 2. Ethofumesate effects on sugarbeet yield across locations in 2017.

Treatment[1]	Root Yield	Extractable Sucrose	Sugar
	-------------ton/A-----------	-------------lb/A------------	--------------%---------------
Untreated Check	28.7	8,485	16.6
32 / 32 / 32 / 32 fl oz/A	28.4	8,532	16.7
June 15 at 128 fl oz/A	28.4	8,513	16.6
July 15 at 128 fl oz/A	28.9	8,610	16.6
Aug 15 at 128 fl oz/A	28.3	8,356	16.4
LSD (0.05)	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Rotational Crop Results:

Wheat, soybean, corn and dry bean stand and development were not impacted by ethofumesate at 9, 10, and 11 months after application (Table 3). Neither a single application of ethofumesate at 128 fl oz/A nor 4 applications at 32 fl oz/A impacted crop injury or stand establishment at any location, regardless of crop.

Table 3. Ethofumesate impact on stand and development across rotational crops in 2018.

Treatment[1]	Wheat		Soybean		Corn		Dry Bean	
	Stand	Injury	Stand	Injury	Stand	Injury	Stand	Injury
	---yd^2---	---%---	---30'---	---%---	---30'---	---%---	---30'---	---%---
Untreated Check	63	0	159	0	44	0	157	0
32 / 32 / 32 / 32 fl oz/A	61	0	155	2	44	5	158	0
June 15 at 128 fl oz/A	60	3	155	2	45	0	153	0
July 15 at 128 fl oz/A	63	3	157	0	45	5	153	0
Aug 15 at 128 fl oz/A	62	0	160	2	45	5	154	0
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Wheat yield components were unaffected by ethofumesate at all rates and timings and were combined across all locations (Table 4). Test weight averaged 56.4 pounds per bushel (lb/bu) with moisture and yield averaging 14.1% and 40.6 bushels per acre (bu/A), respectively.

Table 4. Ethofumesate carry-over impact on wheat yield across locations in 2018.

Treatment[1]	Test Weight	Moisture	Yield
	---------------lb/bu-------------	--------------%----------------	--------------bu/A-------------
Untreated Check	56.7	13.7	40.0
32 / 32 / 32 / 32 fl oz/A	55.7	13.7	41.6
June 15 at 128 fl oz/A	57.0	14.1	40.1
July 15 at 128 fl oz/A	56.8	13.8	40.0
Aug 15 at 128 fl oz/A	55.6	14.1	41.4
LSD (0.05)	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Ethofumesate had no effect on soybean yield at all rates and timings evaluated across all locations. Soybean grown at Lake Lillian, MN, Foxhome, MN and Richville, MI locations had an average moisture and yield of 13.3% and 64.6 bu/A, respectively (Table 5). Soybean yield data from Crookston, MN and Prosper, ND were evaluated separately due to hail storms in June and September, respectively, which decreased the average yield to 37.7 bu/A. However, analyzing soybean yield data when combined across all locations did not reveal any treatment differences.

Table 5. Ethofumsate carry-over impact on soybean yield in 2018.

Treatment[1]	Foxhome, MN; Lake Lillian, MN; Richville, MI			Prosper, ND; Crookston, MN		
	Test Weight	Moisture	Yield	Test Weight	Moisture	Yield
	-------lb/bu------	-----%-----	------bu/A------	-----lb/bu----	-------%------	----bu/A---
Untreated Check	54.3	13.3	63.6	55.4	13.6	38.0
32 / 32 / 32 / 32 fl oz/A	53.8	13.2	65.6	54.8	13.6	38.0
June 15 at 128 fl oz/A	54.2	13.2	64.0	54.4	13.6	36.9
July 15 at 128 fl oz/A	54.1	13.3	62.4	54.6	13.6	39.1
Aug 15 at 128 fl oz/A	55.2	13.3	67.4	54.8	13.5	36.6
LSD (0.05)	NS	NS	NS	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Corn yield components were generally unaffected by ethofumesate at the rates and timings evaluated (Table 6). Corn in Richville, MI showed decreased grain moisture when ethofumesate applications of 128 fl oz/A were made in July and August. Corn grain from these two treatments averaged 15.7% moisture, compared to 16.5% in the untreated check plots. Corn yield data from Crookston, MN was not included in the combined location analysis due to damage from the hail storm in June. Crookston corn yield was 143 bu/A when averaged across treatments versus 229 bu/A when averaged across treatments and the other four locations. This was likely due to weather.

Table 6. Ethofumesate carry-over impact on corn yield in 2018.

	Prosper, ND, Foxhome, MN, Lake Lillian, MN, Richville, MI			Crookston, MN		
Treatment[1]	Test Weight	Moisture	Yield	Test Weight	Moisture	Yield
	--------lb/bu-------	---------%---------	-------bu/ac-------	-----lb/bu-----	-----%-----	--bu/A--
Untreated Check	54.8	18.4	231.8	61.7	15.5	136.7
32 / 32 / 32 / 32 fl oz/A	54.5	18.4	227.4	62.6	16.5	150.2
June 15 at 128 fl oz/A	55.2	18.3	226.2	61.6	15.6	156.1
July 15 at 128 fl oz/A	54.9	18.2	228.9	61.8	15.2	137.0
Aug 15 at 128 fl oz/A	55.3	17.9	229.2	62.6	16.1	136.7
LSD (0.05)	NS	NS	NS	NS	NS	NS

[1]Treatment – ethofumesate was applied at the rates given and at the timings referenced in Table 1.

Dry bean at Richville did not show any growth or developmental reductions from ethofumesate throughout the growing season. Moisture and yield, when averaged across treatment, were 15% and 31.1 bu/A, respectively (data not presented).

Conclusion

Previous studies report ethofumesate residue damaging rotational crops, especially wheat (Schweizer 1975). Ethofumesate in sugarbeet did not damage narrow leaf crops including wheat and corn planted in sequence with sugarbeet in our experiments. However, crop residue at application in previous experiments were different from our experiment. Ethofumesate was applied to bare soil in Schweizer's experiment, which differs from our experiment where ethofumesate was applied post-emergence to sugarbeet from 2- to 22-leaves. The lack of injury observed throughout the growing season is, however, consistent with ethofumesate applied post-emergence literature. Wang P et al. (2005) reported degradation of ethofumesate soil-applied was significantly slower than through plant metabolism. Gardner and Branham (2001) conducted a similar study which found ethofumesate dissipated much faster in plots when applied to turf grass rather than bare soil.

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CONTROLLING COMMON RAGWEED IN FIELDS PLANTED TO SUGARBEET

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Summary

1. For common ragweed that is 0- to 2-inches tall, make a single application of Stinger at 3 fl oz/A plus glyphosate at 0.98 lb ae/A (equivalent to Roundup PowerMax at 28 fl oz/A). A second application of Stinger at 2 fl oz/A plus glyphosate may be needed 14 days after the first application. Herbicide application to small common ragweed provides the greatest control.
2. For common ragweed 2- to 4-inches tall, make a single application of Stinger at 4 fl oz/A plus glyphosate at 0.98 lb ae/A. A second application of Stinger at 3 fl oz/A plus glyphosate may be needed 14 days after the first application.
3. For common ragweed 4- to 6-inches tall, apply Stinger at 4 fl oz/A plus glyphosate. A second application of Stinger at 4 fl oz/A plus glyphosate may be needed 14 days after the first application.
4. Glyphosate resistant common ragweed greater than 6-inches tall can only be partially controlled with POST herbicides in sugarbeet. For maximum control, apply Stinger at 4 fl oz/A plus glyphosate followed by Stinger at 4 fl oz/A plus glyphosate plus high surfactant methylated seed oil concentrate (HSMOC) 14 days after the first application. While this herbicide combination will only provide partial control of common ragweed greater than 6-inches, maximizing spray coverage through increased spray volume and droplet quality may improve control.

Introduction

Common ragweed is a troublesome weed found in both Minnesota and North Dakota. Integrated strategies of cultural, mechanical, and chemical control options are required for controlling this species. Mowing can be an effective strategy, especially in ditches and grass waterways, if done on a regular basis. Two-inch common ragweed is very resilient, especially if only damaged above the seed leaves. Mowed common ragweed can grow new stems and flower just ten days later than plants not mowed. Longevity of common ragweed seed makes managing flushes or complete eradication of this species very difficult. Several soil-applied herbicides labeled for corn and soybean use have activity on common ragweed, however, few herbicides are labeled in sugarbeet that control this species.

Experiments were conducted on natural populations of common ragweed within a sugarbeet field near Mayville, North Dakota in 2014 (Peters and Carlson 2014). The field contained some glyphosate resistant common ragweed biotypes. Treatments included herbicide applications on June 10, 18, 24, and 26, and July 7 and 18, targeting 0-1, ≤2, and 4-inch common ragweed.

Negligible sugarbeet injury was observed in the 2014 experiment. Greatest injury occurred when treatments were applied to 4-inch common ragweed, however, injury was more likely from weed competition than herbicide treatments. Visual sugarbeet injury was greatest after sequential applications of Roundup PowerMax (glyphosate) at 28 fl oz/A plus Stinger at 4 fl oz/A. Visual sugarbeet injury in this experiment, as well as similar trials from 2009 and 2010, was commonly observed when Stinger was applied to cotyledon or 2-leaf sugarbeet at rates of 4 fl oz/A or greater. Sugarbeet injury was inconsistent among treatments and decreased over time.

Weed control in the 2014 study was greatest when treatments were applied to one-inch common ragweed compared to two- or four-inch common ragweed. Treatments containing Stinger averaged 95% ragweed control when applications were made to one-inch or smaller ragweed, 92% control when applications were made to ragweed up to 2-inches tall, and 86% control when applications were made on ragweed up to 4-inches tall. Treatments containing Stinger gave greater common ragweed control, regardless of weed height at time of application, compared to treatments containing only glyphosate.

Materials and Methods

Experiments were conducted on natural populations of common ragweed near Doran, Minnesota in 2018. Plot area was located in a commercial sugarbeet field under conventional tillage. “ACH 830” sugarbeet was seeded 1.25 inches deep in 22-inch spaced rows at 61,500 seeds per acre on May 6. Herbicide treatments were applied May 31, and June 13 and 27. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 42 psi to the center four rows of six row plots 40 feet in length in a field with moderate levels of glyphosate-resistant common ragweed. Ammonium sulfate in all treatments was a liquid formulation from Winfield United called N-Pak AMS.

Sugarbeet injury was evaluated on June 21 and 28. Weed control was evaluated June 21 and 28, and July 11. 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 2018.4 software package.

Table 1. Application Information

Application Code	**A**	**B**	**C**	**D**
Date	May 31	June 13	June 13	June 27
Time of Day	4:30 PM	12:00 PM	12:15 PM	2:00 PM
Air Temperature (F)	82	74	75	85
Relative Humidity (%)	36	36	38	53
Wind Velocity (mph)	8	6	6	3
Wind Direction	N	S	S	SW
Soil Temp. (F at 6”)	68	68	68	76
Soil Moisture	Fair	Good	Good	Good
Cloud Cover (%)	0	20	20	60
Sugarbeet stage (avg)	2-4 leaf	6-8 leaf	6-8 leaf	12-14 leaf
Ragweed (avg)	2”	6”	6”	10”

Results and Discussion

Sugarbeet Injury- Sugarbeet injury evaluation was difficult due to heavy common ragweed competition. Sugarbeet injury was generally greater when herbicide treatments were applied to 6-8 leaf sugarbeet and 6-inch common ragweed compared to applications made to 2-4 leaf sugarbeet and 2-inch common ragweed (Table 2). Of the treatments applied to 2-4 leaf sugarbeet, ethofumesate plus glyphosate gave the greatest injury at 15 to 18%. Sugarbeet injury was 10% or less from Stinger at 2 or 4 fl oz/A applied in either a single or repeat application and could be considered negligible. Sugarbeet injury was greatest when Stinger was applied with glyphosate to 6-8 leaf sugarbeet and 6-inch common ragweed. Two applications of Stinger at 4 fl oz/A plus glyphosate showed the greatest amount of injury at 23% to 28%.

Trials conducted in 2014 (Peters and Carlson 2014) had greater sugarbeet injury from Stinger at 2 to 4 fl oz/A plus glyphosate when applied to 4-8 leaf sugarbeet compared to 2-4 leaf sugarbeet (data not presented). Trials conducted in 2009 and 2010 had greater sugarbeet injury from two sequential applications of Stinger at 4 fl oz/A compared to a single application of Stinger at 8 fl oz/A (data not presented). The 2018 trial was similar in both regards with sugarbeet injury tending to be greater from two applications of Stinger compared to a single application and greater injury when applications were made to larger sugarbeet compared to smaller sugarbeet.

Common Ragweed Control- Common ragweed size impacted control from Stinger plus glyphosate. Herbicide treatments applied to 2-inch common ragweed generally provided greater control than the same treatments applied to 6-inch common ragweed (Table 2). On 2-inch common ragweed, sequential applications of Stinger + glyphosate tended to improve common ragweed control compared to a single application. A single application of Stinger at 4 fl oz/A + glyphosate to 2-inch common ragweed gave 93% control while two applications of Stinger at 4 fl oz/A plus glyphosate gave 100% control. Similarly, a single application of Stinger at 4 fl oz/A + glyphosate to 6-inch common ragweed gave 73% control while two applications of Stinger at 4 fl oz/A plus glyphosate gave 91% control.
Herbicide treatments containing Stinger usually improved common ragweed control compared to glyphosate alone (Table 2). Glyphosate alone gave 73% ragweed control compared to Stinger at 4 fl oz/A plus glyphosate showing 95%

control. These results indicated the common ragweed biotype had some glyphosate resistance. The addition of ethofumesate to glyphosate did not improve control of 2-inch common ragweed.

Acceptable control can be achieved when herbicide applications are made to small common ragweed. Stinger rates should be 3-4 fl oz/A, plus glyphosate, to ensure greater than 90% control. Sequential application increases the likelihood of 100% control, even on small common ragweed. Two sequential applications of Stinger at 4 fl oz/A plus glyphosate will provide the greatest control on common ragweed, however, common ragweed that is 6-inches or greater is too big for a POST herbicide program in sugarbeet to provide acceptable control.

Table 1. Sugarbeet injury and common ragweed control near Doran, MN in 2018.

Treatment	Rate	Application Code[1]	June 21 sgbt injury	June 28 sgbt injury	June 21 cora cntrl	June 28 cora cntrl	July 11 cora cntrl
	fl oz/A	----------	----------	----------	%	----------	----------
2" common ragweed							
PMax [2, 3]	28	A	8	8	73	55	58
PMax+Etho[4]	28+4	A	18	15	73	55	53
PMax+Stinger	28+2	A	5	10	88	85	74
PMax+Stinger	28+4	A	8	5	95	94	93
2" + 14 days							
PMax+Stinger/ PMax+Stinger	28+2/ 28+2	A / B	10	5	99	98	100
PMax+Stinger/ PMax+Stinger	28+4/ 28+4	A / B	8	10	100	100	100
6" common ragweed							
PMax	28	C	5	15	71	78	66
PMax+Etho	28+4	C	18	15	76	71	65
PMax+Stinger	28+2	C	13	25	65	76	72
PMax+Stinger	28+4	C	23	23	65	75	73
6" + 14 days							
PMax+Stinger/PMax+Stinger	28+2/ 28+2	C / D	15	25	78	81	82
PMax+Stinger/ PMax+Stinger	28+4/ 28+4	C / D	28	23	70	76	91
LSD (0.05)			**13**	**14**	**11**	**13**	**15**

[1]Application information is listed in Table 1
[2]PMax=Roundup PowerMax
[3]PMax alone and PMax+Stinger treatments were applied with N-Pak AMS at 2.5% v/v and Prefer 90 NIS at 0.25% v/v.
[4]PMax+Etho treatments were applied with N-Pak AMS at 2.5% v/v and high surfactant methylated oil concentrate (HSMOC) at 1.5 pt/A.

Other Weeds- Common lambsquarters was also evaluated in this trial. Treatments applied to 2-inch common lambsquarters provided 95% control while treatments applied to 8-inch common lambsquarters gave 80% control when evaluated 21 days after application (data not shown). No differences were observed when evaluated 28 days after application.

LITERATURE CITED

1. Peters, TJ and Carlson, AL (2014) Featured weed-common ragweed controlling common ragweed in fields planted to sugarbeet. Sugarbeet Research and Extension Reports.

SUGARBEET SENSITIVITY TO DICAMBA AT LOW DOSE

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SUMMARY

1. Sugarbeet is not as sensitive to dicamba as some other rotational crops.
2. Sugarbeet leaves will lay flat on the ground within a few hours of exposure to dicamba.
3. Leaves may remain more prostrate than normal for the remainder of the growing season.
4. New leaf growth will generally resume around 6 to 10 days after exposure.
5. Dicamba accumulates in roots but metabolizes over time.
6. 1/10x rate (0.05 lb ai/A) was the dicamba rate at which sugarbeet root yield and quality losses were typically observed.

INTRODUCTION

Dicamba is a growth-regulator herbicide consisting of the auxin transport inhibitor compound benzoic acid. It is widely used to control perennial and annual broadleaf weeds in agricultural crops, fallow land, pastures, turfgrass, and rangeland. Dicamba can move in the xylem and phloem to areas of new plant growth; herbicide uptake is primarily through the foliage, but root uptake can occur as well. Dicamba was first registered for use in the United States in 1967. Common formulations of dicamba currently in use include Engenia by BASF, FeXapan plus VaporGrip by DuPont Crop Protection, and XtendiMax plus VaporGrip by Bayer Crop Protection.

The Environmental Protection Agency (EPA) first registered dicamba formulations for 'over-the-top' use on dicamba-tolerant cotton and soybean in 2016. An alarming number of complaints alleging dicamba off-target movement from dicamba tolerant soybean to neighboring sensitive crops were reported to Minnesota and North Dakota Department of Agriculture officials in 2017. To minimize potential future damage to neighboring sensitive crops, EPA and registrants agreed on label changes, implementation of detailed record keeping requirements, and implementation of additional spray drift mitigation measures for the 2018 growing season.

Dicamba-tolerant soybean are commonly grown in the sugarbeet growing areas of the Red River Valley in Minnesota and eastern North Dakota. However, information on the effect of dicamba off-target movement on sugarbeet is insufficient. Experiments were conducted to determine sugarbeet sensitivity to dicamba at low doses simulating off target movement. Experiment objectives were a) to determine sugarbeet injury from dicamba at low doses to simulate off-target movement; b) to determine if dicamba residues accumulate in leaf or root tissue and if they are present at harvest, and c) to determine the impact of dicamba dose on root yield and sugarbeet quality.

MATERIALS AND METHODS

Amenia, North Dakota
Sugarbeet experiments were conducted near Amenia, ND, in 2017 and 2018. The experimental area was prepared with a Kongskilde 's-tine' field cultivator with rolling baskets before sugarbeet planting. 'SES 36271RR' sugarbeet on May 2, 2017 and 'Crystal 981RR' sugarbeet on May 14, 2018 were seeded 1.25-inch-deep in 22-inch rows at 60,825 seeds per acre. Sugarbeet seed was coated with seed treatments for control of soil borne insects and diseases. Dicamba treatments were applied on August 11, 2017 and June 26, 2018 with a backpack sprayer in 17 gpa spray solution through 11002 Turbo Tee (TT) nozzles in 2017 and 11002 Turbo Tee Induction (TTI) nozzles in 2018 pressurized with CO_2 at 40 psi in 2017 and 50 psi in 2018 to the center four rows of six row plots 30 feet in length. For these experiments, the 1x rate of dicamba was 0.5 lb ai/A.

Sugarbeet visual growth reduction and /or malformation injury was evaluated approximately weekly after application. Evaluations were a visual estimate of sugarbeet injury in the four treated rows compared to the adjacent untreated strip. Sugarbeet leaf blade and petiole (plant) and root samples were collected at two time points to simulate preharvest and harvest. Samples were collected beginning with the untreated check plot and ending with the highest dicamba rate to prevent contamination. Five roots were randomly sampled from the treated area of the plot and cleaned with water. The largest and smallest roots were discarded. Roots were cut into pieces and immediately stored in a cooler on wet ice. Samples were shipped in cooler with dry ice to SGS Brookings, Brookings, SD for analysis of dicamba residue.

Sugarbeet were harvested for yield and quality measurement in 2018. Sugarbeet were defoliated with a four-row topper and harvested with a two-row sugarbeet harvester. The sugarbeet roots were weighed to determine root yield (tons/acre). Approximately 25 lbs. of roots were then sampled from each plot and taken to American Crystal Sugar Company Quality Lab, East Grand Forks, MN and analyzed for percent sucrose and sugar loss to molasses (SLM). Purity (%) and recoverable sucrose (lb/acre) were then calculated. Experiment design was an unreplicated strip in 2017 and a randomized complete block design with two replications in 2018. Data were analyzed with the ANOVA procedure of ARM, version 2018.5 software package.

Comstock, Minnesota, and Norcross, Minnesota

Sugarbeet experiments were conducted near Comstock, MN, in 2017 and near Norcross, MN, in 2018. The experimental area was prepared with a King Kutter gear-driven rotary tiller. 'Hilleshög 4062RR' sugarbeet on May 13, 2017, and 'Betaseed 70RR99' sugarbeet on May 15, 2018, were seeded 1.25-inch-deep in 22-inch rows at 63,360 seeds per acre. Sugarbeet seed was coated with seed treatments for control of soil borne insects and diseases. Dicamba treatments were applied on June 19, 2017, and June 20, 2018, with a backpack sprayer in 15 gpa spray solution through XR8002 nozzles pressurized with CO_2 at 40 psi to the center four rows of six row plots 25 feet in length. For these trials, the 1x rate of dicamba was 0.5 lb ai/A.

Sugarbeet canopy was photographed using a DJI Phantom 3 Series drone within 72 hours of treatment and approximately two weeks after treatment. Images were used to calculate Leaf Area Index (LAI). LAI is a dimensionless quantity that characterizes plant canopies; it is defined as the one-sided green leaf area per unit ground surface area in broad leaf canopies (LAI = leaf area / ground area, m2 / m2). Sugarbeet leaf blade and petiole (plant) and root samples were collected at two time points to simulate preharvest and harvest in 2018. Samples were collected beginning with the untreated check plot and ending with the highest dicamba rate to prevent contamination. Three roots were randomly sampled from the treated area of the plot and cleaned with water. Roots were cut into pieces and immediately stored in a cooler on wet ice. Samples were shipped in cooler with dry ice to SGS Brookings, Brookings, SD for analysis of dicamba residue.

Sugarbeet were harvested for yield and quality measurement on September 29, 2017, and September 22, 2018. Sugarbeet were defoliated with a six-row topper and harvested with a three-row sugarbeet harvester. The sugarbeet roots were weighed to determine root yield (tons/acre). Approximately 30 lbs. of roots were then sampled from each plot and taken to Minn-Dak Farmers Cooperative Quality Lab, Wahpeton, ND, and analyzed for percent sucrose and percent purity. Recoverable sucrose as lb/ton and lb/acre were calculated. Experiment design was a randomized complete block design with four replications in 2017 and six replications in 2018. Data were analyzed with the ANOVA procedure of ARM, version 2018.5 software package.

RESULTS AND DISCUSSION

Sugarbeet Injury. Visual sugarbeet injury from dicamba treatments increased over time at Amenia, ND in 2017 (Table 1). Sugarbeet injury from the lowest dicamba rate (1/1000x) increased 6%, injury from 1/100x increased 15%, and injury from 1/10x increased 20%. At both evaluation timings, sugarbeet injury was greatest from the

Table 1. Sugarbeet malformation injury from XtendiMax at 10 days after treatment (DAT) and 35 DAT at Amenia, ND, 2017.

Dicamba Rate[1]	Percent of labeled rate	Sugarbeet injury – 10DAT	Sugarbeet injury – 35 DAT
lb ai/acre		%	%
0.05	1/10x[1]	35	55
0.005	1/100x	5	20
0.0005	1/1000x	0	6

[1]A 1x rate equals 0.5 lb ai/A dicamba.

highest rate and decreased as dicamba rate decreased. Likewise, visible sugarbeet malformation and growth reduction was greater with increased dicamba rate at Amenia in 2018 (Table 2). Plot canopy estimated as leaf area index (LAI) was greatest in the untreated control and with the lowest dicamba rate and was least with the highest dicamba rate. Plot canopy increased as dicamba rate decreased.

Table 2. Sugarbeet visible malformation and growth reduction injury in response to dicamba off-target movement, 12 DAT at Amenia, ND, and plot canopy, 15 DAT, Norcross, MN, 2018.

Dicamba Rate[1]	Malformation	Growth Reduction	Plot Canopy (LAI)
	%	*%*	*cm^2*
High	100 a	100 a	210,000 c
Medium	60 b	50 b	256,900 b
Low	0 c	15 c	289,100 a
Untreated	0 c	0 c	303,300 a
LSD (0.10)	**30**	**17**	**31,400**

[1]High = 1/2x or 1/10x rate; Medium = 1/20x or 1/33x rate; Low = 1/200x or 1/100x rate. A 1x rate equals 0.5 lb ai/A dicamba.

Root yield, sucrose content and recoverable sucrose. Sugarbeet were harvested approximately three months after dicamba application at each location except at Amenia in 2017. Root yield and quality decreased as dicamba rate increased across locations and years (Tables 3, 4 and 5). Differences in sucrose content were not statistically significant in 2017 (Table 3). However, yield and recoverable sucrose were affected by the 1/10x rate dicamba as compared to the untreated check and the 1/100 and 1/33 dicamba rate in 2017.

Table 3. Sugarbeet canopy, root yield, sucrose content and recoverable sucrose in response to dicamba off-target movement, Comstock, MN, 2017.

Treatment[1]	Percent of Labeled Rate	Plot canopy - July 5	Root Yield	Sucrose	Recoverable Sucrose
		cm^2	*ton/acre*	*%*	*lb/acre*
XtendiMax	1/10x	16,400 b	23.9 b	15.3	5,682 b
XtendiMax	1/33x	28,000 ab	27.7 a	15.8	6,889 a
XtendiMax	1/100x	32,500 a	29.9 a	16.1	7,678 a
Untreated		29,700 a	28.4 a	15.0	6,761 ab
LSD (0.10)		**12,900**	**2.6**	**NS**	**1,151**

[1]A 1x rate equals 0.5 lb ai/A dicamba.

Dicamba at 1/10x to 1/2x rate decreased sugarbeet root yield, sucrose content and recoverable sucrose compared to the untreated check at Amenia and Norcross in 2018. Dicamba at 1/00x and 1/33x rate reduced root yield and quality compared to the untreated check at Norcross (Table 5). However, dicamba at 1/200x and 1/20x rate did not affect root yield and quality compared to the untreated check at Amenia in 2017 (Table 4). Root yield and recoverable sugar losses were much greater between 1/10x and 1/2x rate than between 1/200x and 1/20x rate at Amenia and Norcross in 2018 (Tables 4 and 5).

Table 4. Sugarbeet root yield, sucrose content and recoverable sucrose in response to dicamba off-target movement, Amenia, ND, 2018.

Treatment[1]	Percent of Labeled Rate	Root Yield	Sucrose	Recoverable Sucrose
		ton/acre	*%*	*lb/acre*
XtendiMax	1/2x	20.9 c	13.3 b	4,597 c
XtendiMax	1/20x	39.1 a	15.6 a	10,666 a
XtendiMax	1/200x	35.8 b	15.4 a	9,639 b
Untreated		37.8 ab	15.4 a	10,121 ab
LSD (0.10)		**3.2**	**1.4**	**833**

[1]A 1x rate equals 0.5 lb ai/A dicamba.

Table 5. Sugarbeet root yield, sucrose content and recoverable sucrose in response to dicamba off-target movement, Norcross, MN, 2018.

Treatment[1]	Percent of Labeled Rate	Root Yield	Sucrose	Recoverable Sucrose
		ton/acre	*%*	*lb/acre*
XtendiMax	1/10x	9.2 d	16.2 b	2,452 d
XtendiMax	1/33x	22.7 c	17.6 a	6,755 c
XtendiMax	1/100x	25.3 b	17.7 a	7,578 b
Untreated		28.0 a	18.4 a	8,856 a
LSD (0.10)		**2.1**	**1.1**	**578**

[1]A 1x rate equals 0.5 lb ai/A dicamba.

Residue Analysis. Dicamba residue level in leaves and roots decreased as the dicamba rate decreased (Table 6). Leaf tissue had greater levels of dicamba residue than root tissue. Except for leaf tissue at the labeled dicamba rate, the amount of residue in tissues declined between the first and second sampling date. Dicamba treatments were not applied until August 11 at Amenia in 2017 or much later than mid to late June or typical soybean application timing.

Sampling was timed to simulate August sugarbeet preharvest (58 to 69 DAT) and full harvest in October (84 to 94 DAT) and followed dicamba application to simulated off target movement from application in soybean in 2018. Dicamba was virtually undetectable in leaf and root across sampling timings and locations in 2018 (Tables 7 and 8). There was no dicamba residue detected in the roots 84 to 94 DAT.

Table 6. Dicamba residue measured in sugarbeet leaf and root tissue, 17 and 38 DAT, Amenia, ND, 2017.

		17 DAT		38 DAT	
Rate	**Percent of Labeled Rate**	**Leaf**	**Root**	**Leaf**	**Root**
lb ai/acre		---------------------------------*ppm*---------------------------------			
0.5	1x	0.57	0.48	1.40	0.47
0.05	1/10x	0.11	0.07	0.07	0.06
0.005	1/100x	0.12	0.01	0.01	0
0.0005	1/1000x	0	0.001	0	0
0		0	0	0	0

Table 7. Dicamba residue measured in sugarbeet leaf and root tissue, 58 and 84 DAT, Amenia, ND, 2018.

		58 DAT		84 DAT	
Rate	**Percent of Labeled Rate**	**Leaf**	**Root**	**Leaf**	**Root**
lb ai/acre		----------------------------------*ppm*--------------------------------			
0.25	1/2x	0.165	0.110	0.027	0
0.025	1/20x	0.045	0	0	0
0.0025	1/200x	0	0	0	0
0	Untreated	0	0	0	0

Table 8. Dicamba residue measured in sugarbeet leaf and root tissue, 69 and 94 DAT, Norcross, MN, 2018.

		69 DAT		94 DAT	
Rate	**Percent of Labeled Rate**	**Leaf**	**Root**	**Leaf**	**Root**
lb ai/acre		----------------------------------*ppm*--------------------------------			
0.05	1/10x	0.014	0.030	0	0
0.165	1/33x	0.012	0	0	0
0.005	1/100x	0	0	0.003	0
0	Untreated	0	0	0	0

CONCLUSION

Sugarbeet is not as sensitive to dicamba as other crops including soybean or sunflower. Sugarbeet injury following dicamba off target movement will occur within a few hours of exposure. Sugarbeet leaves will lay flat on the ground, regardless of rate, but a higher dosage will lead to greater visible injury. Leaves may remain more prostrate than normal for the remainder of the growing season, especially if the injury is severe. Leaf petioles will exhibit twisting, also called epinasty. New leaf growth generally resumes six to ten days after exposure and the new leaves will often be malformed with wrinkled leaf margins, parallel veins, or leaf strapping. Dicamba is rapidly metabolized by sugarbeet and it is unlikely dicamba residue will be detected in the roots at harvest.

CHICORY ROOT PRODUCTION

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SUMMARY

1. Chicory is a root crop cultivated to produce inulin which is a prebiotic fiber.
2. There are similarities in production practices and equipment for chicory and sugar beet production suggesting commercial production in the Red River Valley (RRV) is viable.
3. Chicory emergence, growth and development, and root yield in an experiment conducted near Prosper, ND in 2018 was similar to production in Nebraska.
4. Inulin content in chicory roots harvested near Prosper, ND was similar to inulin content in roots harvested in Nebraska. Low bitterness also was measured making the RRV a viable location to grow chicory roots for Blue Prairie Brands, Inc. More research is needed to determine inulin functionality and potential end uses.
5. Chicory production is preferred in irrigated fields due to shallow seed placement at seeding.

BACKGROUND

Society is currently subjected to diet-related medical illnesses including obesity, coronary heart disease, and diabetes. There growing prevalence highlights the importance of research to investigate functional foods that may improve health. Chicory is one such food. Chicory is an herbaceous plant, with several cultivated varieties in the United States, including: *Cichorium endivia*, grown for its edible leaves such as escarole and curly endive; *Cichorium intybus*, which has edible leaves and roots; and Witloof or Belgian endive roots, which are harvested and then grown in the dark to produce blanched leaves that are consumed in salads.

Industrial chicory root is a subspecies of *Cichorium intybus* known as sativium and is cultivated to produce fructose and the valuable soluble fiber, inulin. Made popular in North America by General Mills' FiberOne products, inulin is a sugar that cannot be digested. Known as a prebiotic, inulin provides energy to the probiotic microbes in our gut which in turn provides health benefits. Currently production is centered in Northern Europe and serves a rapidly growing global market valued over $1.3 billion. With increased demand for this fiber source in the United States, domestic production of inulin for large food companies (e.g. General Mills, Cliff Bar, etc.) needs to be explored further, and integrated into established cropping systems throughout the country. Chicory root production currently is leading this effort.

The production of chicory roots for inulin has become an important segment of the world chicory market. Over 20 years ago, University of Nebraska professor, Dr. Robert Wilson, recognized the potential of chicory root as a rotation crop for sugarbeet growers in the Panhandle "High Plains" region in Nebraska. Chicory root cultivation leverages existing sugarbeet growing practices, infrastructure, machinery, and land to produce a root crop possessing the valuable fiber source, inulin. Growers producing sugarbeet have experiences and machinery to grow root crops similar to chicory. No new equipment is needed, and root chicory is added to a rotation without replacing existing sugarbeet production. A grower could replace a lower margin commodity crop such as corn or dry beans with a high margin root crop. With adequate field management, chicory roots can be readily adopted by sugarbeet growers interested in additional crop markets. Standard crop management practices have been developed for chicory production and should be followed to achieve desirable yields.

Field Selection

Several factors need to be considered before selecting a field for chicory production. The high input system required of chicory should not be put at risk with poor field selection. Fields optimal for chicory production should have well balanced soil fertility that is ideally under pivots (irrigated), well drained, and subject to multiple weed management strategies annually. Chicory can be grown in different soil types, but soil with heavy clay can create problems with irrigation/drainage and at harvest with cleaning roots prior to processing. Previous crop should be a grass including corn or small grains. It is recommended to avoid the use of winter wheat or other spring harvested cereals prior to planting chicory in the same field as it may introduce insect pests such as cutworm during the emergence window for chicory.

Planting and Irrigation

Chicory should be planted as early as possible in the spring in order to extend the growing season and maximize root yields. At time of planting, the soil should be free of compaction layers to a depth of 14 to 18 inches for the taproot to elongate naturally. Moldboard plow and "zone" tillage are the most frequently adopted strategies to prepare a level seed bed to seed chicory seeds. Chicory is planted using standard sugarbeet planting equipment. which typically results in chicory planted in rows spaced either 22 or 30 inches apart. Growing chicory with a narrow row spacing is ideal because it will result in canopy closure in the summer much sooner, helping manage any weed problems until harvest in fall. Chicory seed needs to be planted no more than approximately 0.5 inch deep. Soil surface should be firm, so one can achieve accurate depth control. Plant population between 60,000 to 80,000 plants per acre at harvest is optimum. Therefore, one should seed 100,000 seeds per acre or seed spacing of 2 and 7/8 inches between seeds in rows spaced 22 inches apart. Access to irrigation is critical as soil must be kept moist for at least 7 to 10 days for seeds to germinate and establish structural roots. Irrigation should continue from the spring through fall months as needed. The volume of irrigation water used will rely on several factors including the field soil water holding capacity (texture), and ambient weather conditions.

Emergence and Field Scouting

Chicory will start emerging about 7 to 10 days after planting. There are currently no hybrid varieties of root chicory available to the growers and there are no glyphosate resistant varieties of chicory. Thus, growers need to take a strategic approach to weed management. There are only a few herbicides approved for use since chicory is still considered a "new crop" in the United States. A preplant broadcast application of Treflan (trifluralin) must occur before planting. Irrigation water cannot be used to incorporate Treflan as it is very insoluble in water. This results in the concentration the Treflan right over the chicory seedling which kills or injures the crop. Raptor (imazamox) is approved as a post-emerge herbicide to control for weeds in chicory. Apply Select Max (clethodim) to control grass weeds or volunteer corn if the field previously was planted to corn and volunteer corn is a production challenge. Growers should row-cultivate chicory as needed for weed control and wind erosion protection if adequate weed control is not achieved with herbicide. Hand-weeding may also be needed to remove weed escapes.

Fertility

Root chicory requires nitrogen, phosphorous and potassium as well as magnesium and boron for optimum yield. Soil tests (no more than 3 years old) from the field for both primary and secondary nutrients is important so that accurate fertilizer recommendations can be made. For nitrogen, there needs to be about 100 pounds of available nitrogen in the upper 3 feet of soil. Nutrients can be applied before planting or side dressed after the crop has emerged. Do not place nitrogen in the seed furrow with the planter as it may affect seed germination.

Harvest

Chicory roots are typically harvested in late September to early November in Nebraska. The date of harvest can significantly impact the root weight and inulin content in the roots. Root yields can nearly double from the first of September to mid-November. Chicory roots contain nearly 70% inulin on a dry matter basis, so it is important to consider the inulin composition (chain-length) prior to harvest, as this will impact the end use of the recovered inulin as a functional food ingredient. While there are similarities between chicory and sugarbeet harvest methods (e.g. defoliating, monitoring soil moisture and temperature (pulp) conditions at harvest), there remain important differences that will determine the recovered yield from the field. Chicory is typically much smaller in diameter, with longer taproots compared to sugarbeets making them harder to remove from the soil. While a sugarbeet harvester (often equipped with grab rolls and a squeeze or "scrubber" chain elevator) is recommended to harvest chicory roots, modifications to the implement are necessary to accommodate the different root shape and size. Narrower gaps in scrubber chains, softer grab rolls, and adjustments to the pinch wheels are several of the accommodations that are needed to effectively harvest chicory roots in the fall without significant loss.

Storage
Depending on the intended end-use, chicory roots can be stored using several different methods. Like sugarbeet, chicory roots can be frozen and stored in large ventilated outdoor piles for several months. Other ways to extend the processing window for chicory roots includes storing it indoors under similar conditions utilized for potato storage.

Blue Prairie Brands
Over two decades of dedicated research has resulted in the development of cropping systems that successfully grow chicory roots in Nebraska. Blue Prairie Brands chicory flour is a product developed in Nebraska through years of research and development. Identification of a low bitter chicory variety was performed at the University of Nebraska Panhandle Research & Extension Center. The company developed a proprietary processing method to produce a low bitter chicory flour and continues to explore its applications as a functional food ingredient in multiple end-use scenarios including: extruded rice and corn puffs, cookie doughs, chewy fiber bars, high fiber pasta and other high fiber foods.

With the market demand for inulin increasing annually, Blue Prairie Brands is beginning to explore other areas of the United States in addition to the Panhandle of Nebraska where sugarbeet are grown, including the Red River Valley. With future market demand in mind, an experiment was conducted in the Red River Valley to determine growth and development and yield of a low-bitterness root-chicory variety and determine if root-chicory grown in the Red River Valley maintain product concept levels of inulin (soluble fiber) and low bitterness trait.

MATERIALS AND METHODS

Experiments were seeded near Prosper, ND and Rothsay, MN in 2018. Experimental design was a randomized complete block with three replications. The experiment at Rothsay was terminated in June due to inadequate chicory stands. At Prosper, the experimental area was prepared on May 11, 2018 with a Kongskilde 's-tine' field cultivation equipped with roiling baskets. Soil sampling conducted the previous fall indicated nutrient levels of nitrogen, phosphorus, and potassium at 18 pounds per acre, 44 parts per million (ppm), and 270 ppm, respectively, with an organic matter of 3.9. Treatments were broadcast urea fertilizer (46-0-0) at 0, 60, and 120 lb/acre. Tillage immediately followed broadcast fertilizer application. 'Chrysolite' chicory was seeded 0.25-inch deep in 22-inch rows at 110,000 seeds per acre on May 14, 2018. Individual plots were 6 rows wide by 30 feet long. Experimental area was hand-weeded as needed and Rhizoctonia root and crown rot caused by *Rhizoctonia solani* and Cercospora leaf spot caused by *Cercospora beticola* were controlled with soil and foliar fungicides as needed to reduce overall effects of disease.

Chicory stand density was evaluated June 5, June 15 and June 22 by counting number of chicory plants in 10 feet of row, in the middle two rows (rows 3 and 4) in each 6-row plot. Chicory growth and development was determined by counting leaf numbers of random plants in rows 3 and 4 on July 2, July 12, July 20, July 24 and July 31. Chicory was hand-harvested on September 20, 2018 and October 17, 2018 by taking 5-feet of row from rows 3 or 4 at both front and back of the plot, totaling 10-feet row per plot. Samples were sent to Blue Prairie Brands, Gering, NE for quality analysis.

RESULTS

Chicory stand density was numerically greatest in the untreated check and density was less in plots with fertilizer treatment (Table 1). It is possible chicory germination and emergence was influenced by tillage following fertilizer treatments. Chicory is seeded 0.25-inch-deep and moisture loss from tillage may have reduced germination and emergence. Treatment differences tended to decrease as the number of days after seeding increased. However, chicory germination and emergence is an agronomic challenge due to very shallow seeding rate. The experiment near Rothsay, MN experienced unacceptable stand establishment and was terminated even though the experiment was planted into moisture. Chicory is planted in fields with overhead irrigation in Nebraska and probably should be planned for fields in Minnesota and North Dakota with irrigation to ensure acceptable stand establishment.

Table 1. Chicory stand density per 100 ft row at Prosper, ND in 2018.

Treatment	June 5	June 15	June 22
	Evaluation date		
	------------------------Number per 100 feet-------------------------		
Untreated Check	73	67	140
Urea, 60 lb/A	38	48	112
Urea, 120 lb/A	48	48	107
LSD 0.05	NS	NS	NS

There were no visual differences in chicory growth and development across fertilizer treatments (Figure 1). Chicory plants were at the 6-leaf stage on July 2 and the 23-leaf stage on July 31. Chicory averaged approximately 4-leaves (2 pairs) per week. Chicory plants covered the row (22-inch spacing) on approximately July 25. No visual differences in susceptibility to springtail, Rhizoctonia root and crown rot, or Cercospora leaf spot were observed in chicory compared to other sugarbeet experiments conducted at Prosper, 2018.

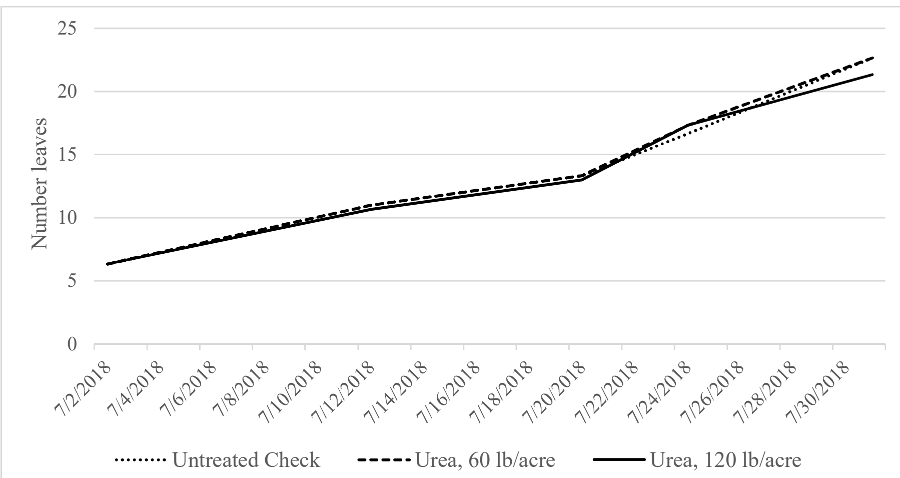

Figure 1. Average number of chicory leaves per plant from July 2 to July 31 when fertilized with urea (46-0-0) at 0, 60, 120 lb/acre, Prosper ND, 2018.

Chicory root and inulin yields in the RRV compared favorably to Nebraska (Figure 2 and Figure 3). Chicory root yield ranged from 17 to 19 ton per acre (ton/A) across treatment at Prosper compared to 14 tons per acre at Nebraska. Inulin yield averages were 4376 pounds per acre (lb/A) to 9076 lb/A in Nebraska and Prosper, respectively. It should be reiterated that yields from the Prosper trial were taken by hand harvesting while yields from Nebraska are from commercial fields using modified sugarbeet lifters where approximately 1 to 3 tons per acre harvest loss occurs due to roots escaping harvest equipment.

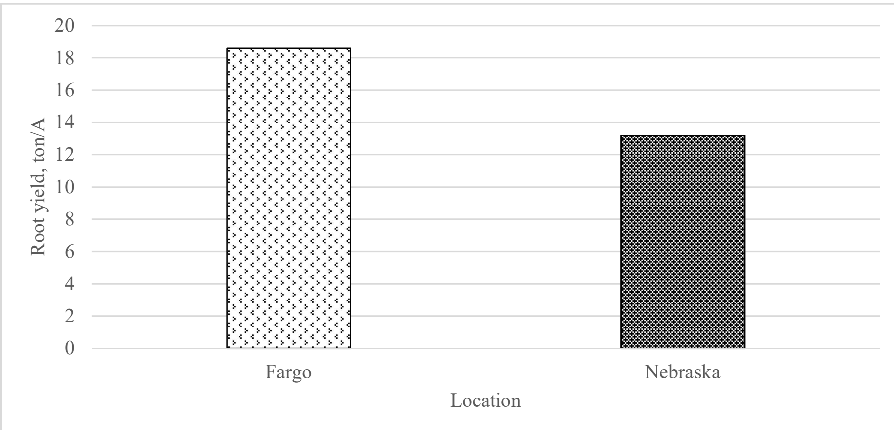

Figure 2. Chicory harvest root yield when fertilized with urea (46-0-0) at 0, 60 and 120 lb/acre, Prosper ND in 2018.

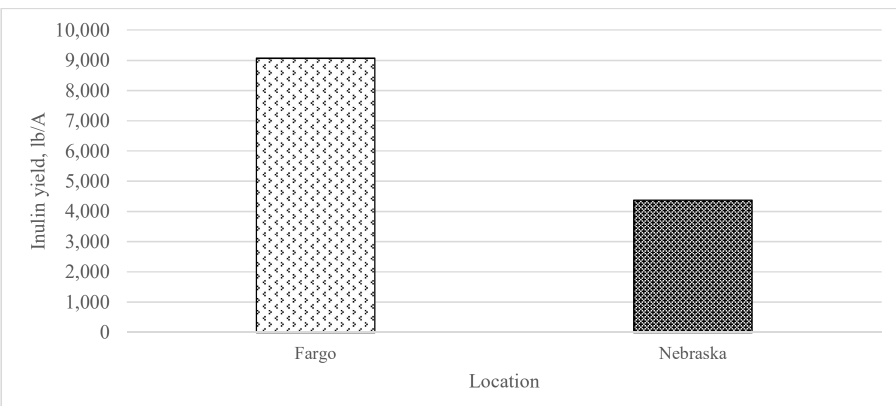

Figure 3. Inulin yield from chicory across urea (46-0-0) fertilizer rate, Prosper ND and compared to Nebraska, 2018.

Inulin soluble dry matter content was measured using a refractometer. Soluble dry matter content ranged from 20 to 25 (no units) depending on urea fertilizer rate and harvest date (Figure 4). Generally less fertilizer gave greater soluble dry matter. Soluble dry mater of 21 to 26 is desired by Blue Prairie Brands for optimum quality. Bitterness was also measured in chicory roots from this trial and was found comparable across treatments to bitterness measured in Nebraska chicory roots (data not shown).

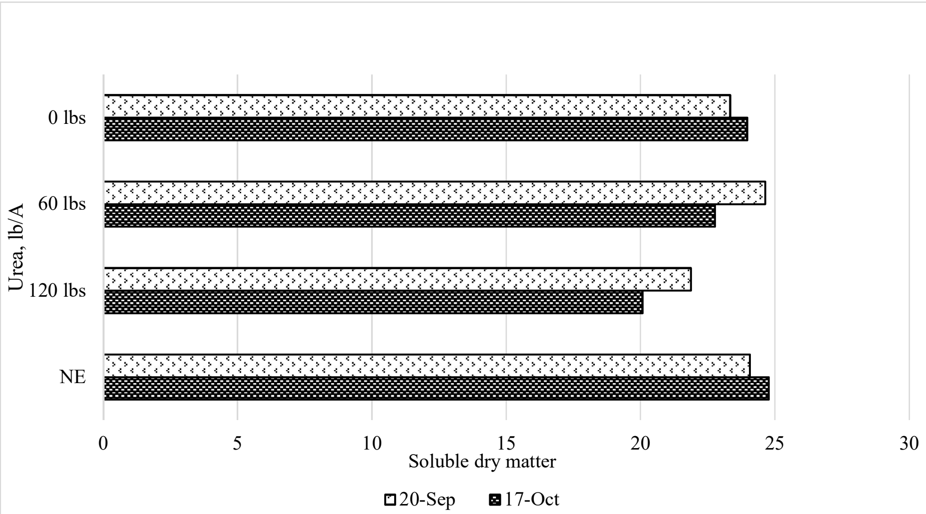

Figure 4. Soluble dry matter as measured by refractometry, Prosper, ND, 2018.

SUMMARY

Many agricultural producers in the Red River Valley (RRV) have experience with and equipment for growing root crops like sugarbeet. These are valuable factors in determining where chicory root production could be viable. Chicory grown under various nitrogen rates in a trial at Prosper, ND in 2018 had root yield, inulin content, and low bitterness metrics similar to chicory grown in Nebraska. Stand establishment was the main challenge in the experiment conducted at Prosper and emphasized the importance of early season moisture required for adequate stand establishment. Chicory production in the RRV may be viable alternative to sugarbeet or other row crops in the future. However, more research evaluating agronomics are needed before chicory can be considered an alternative crop in RRV.

SOIL MANAGEMENT PRACTICES

NOTES

DETERMINING NUTRIENT RELEASE CHARACTERISTICS OF VARIOUS MANURES

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Justification for Research:

Using manure as a nutrient source can be more complicated than using commercial fertilizers since the nitrogen (N) and phosphorus (P) content can vary depending on species, storage and treatment methods, and application techniques. Farmers, particularly those that grow sugarbeets, are also concerned about when the nutrients are released in the growing season which changes depending on soil types and weather. Despite concerns, there are other benefits of manure beyond being a source of N and P, including improving soil health and providing micronutrients. Plus, the up and down price swings of the commercial fertilizer market make manure more attractive, especially if a farmer has a consistent supply which can offset fertilizer costs.

To help farmers understand nutrient management with manure, the University of Minnesota developed recommendations to help determine N and P credits for a variety of manures. These recommendations were developed several decades ago, however, and since that time the diets of animals, storage of manures, and manure application equipment have changed. As one example, the recommendations to determine N availability treat all dairy liquid manure the same. However, some dairies have implemented technology to separate the solids from the liquids, thus changing the nutrient dynamics of the manure. Will liquid separated dairy manure have the same N availability as unseparated liquid dairy? For both N and P, are there differences in mineralization across soil types? These questions are particularly important for sugarbeet growers due to the effect late season N availability in the soil has on the sugar content of their crop. Our goal is to better understand N and P release from manure so that farmers are able to make better decisions about when to apply manure in their rotation to maximize benefits while reducing fertilizer costs.

Summary of Literature Review:

Understanding N availability in manure is complicated. The amount that is available will depend on the animal species that made the manure, what kind of bedding (if any) was used, how the manure was treated and/or stored, and how the manure was applied. The University of Minnesota has recommendations for what to expect for N availability (Hernandez and Schmitt 2012), but may need updated since there are new manure handling technologies and feeding and bedding strategies being used today. For example, Russelle et al. (2009) found that nutrient release estimates for stratified bedded pack dairy manure were not consistent with solid dairy manure guidelines in Minnesota. With new state regulations pending regarding how much fertilizer N is applied to fields, farmers that also use manure will need to take great care in determining how much N is supplied from the manure before determining how much fertilizer they can apply.

Understanding P availability in manure is also necessary, and luckily is not quite as complicated as it is with N, although there are still uncertainties. We assume approximately 80% of the total manure P is available the first year, but even this can vary depending on weather conditions. Recent studies have shown, however, that P availability may also depend on soil texture (Pagliari and Laboski 2014). In a recent study done at the University of Wisconsin, Pagliari and Laboski (2013; 2014) found that from 40% to 100% of P from manure became plant available within 50 days and the difference was primarily due to manure chemistry and soil texture.

Objectives:

The objective of this study is to evaluate N and P release from a variety of manures and soil types to give farmers a better understanding of how manure will behave.

Materials and Methods:

Laboratory incubations were used to assess N and P release characteristics from a variety of manures in several different soil types. The incubation studies were a complete factorial with 4 replications and with manure type, soil type, and temperature as the main factors. This means all possible soil and manure combinations were tested at all chosen temperatures. We also included a control treatment that did not include any manure application to see how much nitrogen and phosphorus mineralized from the soils themselves. We tested 8 manures, including: dairy liquid (separated and raw [non-separated]), swine liquid (from a finishing house and a sow barn), beef manure (solid bedded pack and liquid from a deep pit), and poultry (turkey litter and chicken layer manure). Manure analyses to determine nutrient content were conducted on all samples prior to incubations. Soils for the incubations included a coarse textured soil from the Sand Plain Research Center at Becker, MN; a medium textured soil from a research field near Rochester, MN; and a fine textured soil from the West Central Research and Outreach Center in Morris, MN. Soils were collected from the top six inches of soil at each location in bulk and then air dried and analyzed for nutrient and organic matter content.

To determine how much plant available N and P was released over time, we made subsamples for each manure by soil type by temperature treatment, and then collected one each at predetermined sampling intervals. Each subsample consisted of 200 grams of soil placed into ball jars and brought to about 60% moisture. These were allowed to incubate for a week prior to manure being added. After one week, manure was mixed into the jars to mimic a given amount of nutrient (e.g. 180 lbs of N per acre). We used the University of Minnesota guidelines and manure analysis results to calculate the appropriate application rate for each manure type. Moisture in the samples was kept at 60% of field capacity and was maintained by weighing every 4-6 days and adding deionized water as needed to replace the weight lost. During the incubation study, the temperature inside the incubator was kept at either 25ºC (77ºF), 15ºC (60ºF), or 5ºC (40ºF). We collected subsamples at 0, 7, 14, 28, and 56 days after the experiment had begun. Subsamples were destructively analyzed for potassium chloride extractable ammonium and nitrate and Bray-1 or Olsen extractable phosphate.

Preliminary Results:

At the time of writing, the experiment has only been run at one temperature, 25ºC (77ºF) and subsamples for days 0-28 have been collected. Ammonium and nitrate have been analyzed for subsamples for days 0-14. The remaining treatments will be completed later in 2019. Statistical analyses have not been conducted at this time.

The results of the initial soil and manure tests can be found in Tables 1 and 2, respectively. This will give an idea of the starting conditions of the soils and manures. For the incubation at 25ºC, the amount of ammonium-N, nitrate-N, and inorganic N (ammonium + nitrate) from each treatment from days 0-14 can be found in Table 3. For visual reference, Figure 1 shows the inorganic N (ammonium + nitrate) from each treatment from days 0-14. The control samples showed that more inorganic N was present in the medium textured soil than the other soils. In general, the swine manure from both finisher and sow barns released the most inorganic N compared with other manures. Of the beef manures, the liquid deep pit manure tended to release more inorganic N than the bedded pack manure, likely due to the lack of bedding to tie up nitrogen. Of the dairy manures, the raw and liquid separated tended to release inorganic N similarly, except in the medium textured soil where the liquid separated manure released more inorganic N. Across soil types, the inorganic N release tended to be stable in the coarse textured soil, while in the medium and fine textured soil, it appears to have increased initially then slowly decreased. It is unclear why this may have happened but could be due to volatilization of ammonium, denitrification of nitrate, or immobilization of N into organic forms. More tests are needed and will be completed later in 2019.

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- Russelle MP, Blanchet KM, Randall GW, Everett LA. 2009. Characteristics and nitrogen value of stratified bedded pack dairy manure. Crop Management 8(1). https://dl.sciencesocieties.org/publications/cm/abstracts/8/1/2009-0717-01-RS.

Table 1. Initial characteristics of three soil types used in this study: coarse textured soil from Becker, MN; medium textured soil from Rochester, MN; and a fine-textured soil from Morris, MN.

Soil Characteristics	Soil Textural Class		
	Coarse	Medium	Fine
Organic matter (%)	1.1	1.0	3.3
pH	5.1	5.2	7.9
Phosphorus - Olsen (ppm)	11	8	7
Potassium (ppm)	95	101	140
Magnesium (ppm)	42	49	570
Calcium (ppm)	274	310	3482
Ammonium (ppm)	3.4	2.8	8.6
Nitrate (lb/acre)	3.0	2.5	8.5

Table 2. Initial characteristics of eight manure types used in this study. The units of nutrients will be in pounds per ton for solid manure and in pounds per 1000 gallons for liquid manure.

Species Type	Manure Type	Moisture	Total N	Ammonium-N	Total P (as P_2O_5)	Total K (as K_2O)	C:N Ratio
		(%)	(lbs per unit)	(lbs per unit)	(lbs per unit)	(lbs per unit)	
Beef	Bedded Pack, Solid	60.5	13.43	2.37	9.59	18.01	22:1
	Deep Pit, Liquid	86.6	56.72	36.7	23.43	30.83	9:1
Dairy	Separated, Liquid	93.2	32.7	15.8	13.31	29.26	7:1
	Raw, Liquid	88.9	33.17	15.66	13.08	31.29	13:1
Swine	Finisher, Liquid	86.8	59.16	41.63	37.63	27.35	9:1
	Sow, Liquid	99.3	16.5	15.69	1.38	11.34	1:1
Poultry	Chicken Layer, Solid	48.6	55.51	14.39	35.78	25.91	7:1
	Turkey Litter, Solid	53.0	28.2	13.16	26.69	28.65	12:1

Table 3. The amount of ammonium-N (NH_4-N), nitrate-N (NO_3-N), and inorganic-N (the sum of ammonium-N + nitrate-N) in soil mixed with various manure types in three different soil textural classes.

Species Type	Manure Type	Day 0			Day 1			Day 7			Day 14		
		NH_4-N	NO_3-N	Inorganic -N	NH_4-N	NO_3-N	Inorganic -N	NH_4-N	NO_3-N	Inorganic -N	NH_4-N	NO_3-N	Inorganic -N
		-------------lb/acre-------------			-------------lb/acre-------------			-------------lb/acre-------------			-------------lb/acre-------------		
Coarse Textured Soil													
Control	None	3.4	6.0	9.3	14.3	0.0	14.3	6.3	10.1	16.4	8.2	5.9	14.1
Beef	Bedded	17.6	1.1	18.7	16.2	0.0	16.2	11.0	8.9	19.9	12.3	9.0	21.2
	Deep Pit, Liquid	75.6	0.0	75.6	129.8	0.0	129.8	42.2	18.7	60.9	48.0	10.9	58.9
Dairy	Separated, Liquid	55.3	0.0	55.3	48.4	0.0	48.4	60.8	8.0	68.8	44.9	9.8	54.6
	Raw, Liquid	32.1	0.0	32.1	62.0	0.0	62.0	59.2	1.8	61.0	28.1	20.5	48.6
Swine	Finisher, Liquid	65.6	0.5	66.2	82.6	0.0	82.6	81.9	10.3	92.2	45.3	19.6	64.8
	Sow, Liquid	102.5	0.0	102.5	139.5	0.0	139.5	103.7	20.4	124.2	73.8	48.7	122.5
Poultry	Turkey Litter, Solid	41.1	1.0	42.2	49.0	0.0	49.0	38.5	16.0	54.5	18.1	14.3	32.4
	Chicken Layer, Solid	90.8	5.6	96.5	108.1	0.0	108.1	116.5	12.3	128.9	38.5	32.1	70.7
Medium Textured Soil													
Control	None	6.3	44.9	51.2	13.2	59.8	73.1	12.4	60.8	73.2	11.7	45.1	56.9
Beef	Bedded Pack, Solid	4.3	50.8	55.2	17.9	79.1	97.0	13.7	88.1	101.9	9.8	12.7	22.5
	Deep Pit, Liquid	15.5	112.6	128.1	11.7	91.6	103.3	8.7	85.2	93.9	9.0	43.6	52.6
Dairy	Separated, Liquid	6.2	101.7	108.0	14.4	87.9	102.2	6.9	101.3	108.3	7.9	55.6	63.5
	Raw, Liquid	2.5	68.4	71.0	16.9	71.5	88.4	6.3	41.5	47.8	8.3	20.6	29.0
Swine	Finisher, Liquid	54.0	100.6	154.6	25.3	122.7	148.1	7.6	0.0	7.6	7.5	88.9	96.4
	Sow, Liquid	25.1	123.8	148.8	27.2	152.1	179.2	5.9	0.0	5.9	8.5	141.2	149.7
Poultry	Turkey Litter, Solid	0.0	95.5	95.5	5.6	104.1	109.7	3.3	105.2	108.5	11.3	47.3	58.5
	Chicken Layer, Solid	2.0	99.9	102.0	28.8	141.2	170.1	4.3	0.0	4.3	8.6	52.9	61.6
Fine Textured Soil													
Control	None	0.0	7.2	7.2	7.2	28.4	35.6	8.9	18.0	26.8	12.7	13.1	25.8
Beef	Bedded Pack, Solid	0.0	15.3	15.3	8.5	23.0	31.5	5.5	7.3	12.8	9.8	8.1	17.9
	Deep Pit, Liquid	5.0	78.8	83.8	31.4	24.7	56.1	13.7	50.3	64.0	15.4	16.3	31.7
Dairy	Separated, Liquid	1.4	50.7	52.1	26.0	22.8	48.8	12.3	34.9	47.2	14.3	29.5	43.8
	Raw, Liquid	9.3	1.0	10.4	18.3	41.9	60.2	13.4	29.2	42.7	14.2	12.3	26.5
Swine	Finisher, Liquid	18.4	1.7	20.1	62.2	30.3	92.5	15.9	126.6	142.5	16.5	13.8	30.3
	Sow, Liquid	12.2	4.5	16.7	65.6	44.9	110.5	40.7	136.9	177.5	24.1	101.8	126.0
Poultry	Turkey Litter, Solid	9.6	3.9	13.6	18.0	53.5	71.5	13.4	68.7	82.1	14.2	10.2	24.4
	Chicken Layer, Solid	15.1	2.1	17.2	83.7	19.4	103.0	22.6	102.0	124.6	13.4	16.4	29.8

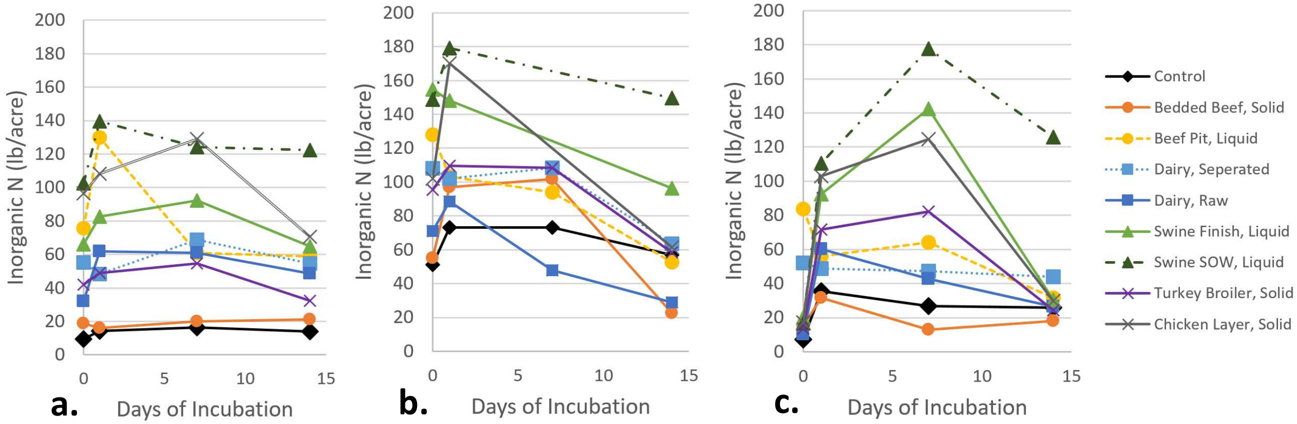

Figure 1. The amount of inorganic-N (the sum of ammonium-N + nitrate-N) in soil mixed with various manure types in: a. coarse textured soil from Becker, MN; b. medium textured soil from Rochester, MN; and c. fine textured soil from Morris, MN.

EFFECT OF SEEDING TIME AND INTER-SEED COVER CROPS ON SUGARBEET YIELD AND QUALITY

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Red River Valley of North Dakota and Minnesota is a major sugar beet production region in the United States. After sugarbeet is harvested, soil is mostly exposed to wind and water erosion due to less residue is left over. Growers have reported significant soil loss from their field and deposition in ditches after harvest. Integrating covercrops in the sugarbeet cropping system will reduce the soil erosion. Benefits from cover crops also include erosion reduction, promoting pest-suppression, and improving soil and water quality, (Frye et al. 1985, Lal et al. 1991, Reicosky and Forcella. 1998, Snapp, et al., 2005, Weil, et al., 2009). Production practices allows only for a short window for cover crop establishment in the fall and this may not be enough time for some cover crop species to establish and provide agronomic benefits. Interseeding or sowing cover crop into a standing cash crop, is a way to get a jump on the traditional winter cover crop season. Interseeded cover crop may provide protection against wind and water erosion soon after sugar beet harvest. Under this management practice, the cover crop get established prior to canopy closure, and then survive to the end of the growing season without creating too much competition for resources for the sugarbeet crop. However, the adoption of cover crop inter seeding has been limited to only a few production regions (Bittman and Schmidt, 2004; Abdin et al., 1998). So, this field experiment was conducted to compare interseeding in June vs July and performance of four cover crops species on sugarbeet yield and quality at Ada and Downer of Minnesota.

OBJECTIVES

1. Effect of seeding time and different inter-seeded cover crops on sugar beet yield and quality and cover crop biomass production
2. Effect of cover crops on soil nitrate-nitrogen availability for 0-6" depth at the end of the season

MATERIALS AND METHODOLOGY

This study was conducted at two sites; Ada (N 47° 19' 39.8") and Downer (46° 51' 52.3"), MN. The experiment was laid out in split plot which included five cover crop treatments; check (no cover crop), winter rye (*Secale cereal* L.)cv. ND Dylan, winter camelina (*Camelina sativa* L.) cv. Joelle, winter Austrian pea (*Pisum Sativum* L.), mustard (*Sinapis alba* L.) cv. Kodiak, as main plot and two cover crops planting time (June and July) as sub plot with four replication.. Individual treatment plots measured 11 feet wide and 30 feet long. The sugar beet seeds were planted 4.75" apart. Sugar beet planting was done at May 3 and 7 for Downer and Ada respectively. For Ada, first cover crop planting was done on June 21st and second on July 11th whereas for Downer; first and second cover crop planting was done on June 27th and July 16th respectively. Prior to planting, soil nutrient levels were measured and recommended NPK fertilizers were applied.

Standard sugar beet cultivar were planted and the cover crops were inter-seeded in between sugar beet rows using a hoe. A 22 inches row spacing was used. Fungicide applications were done thrice, for the control of fungal diseases such as Cercospora in sugar beet. Hand weeding was done to control other weeds in between the crops. The cover crop biomass were measured just before the harvest and 0-6" depth soil samples were analyzed for inorganic nitrogen concentration. Sugar beet was harvested on September 17th and 26th for Downer and Ada respectively. The middle two rows of each plot was harvested and subsamples was analyzed for quality parameters. Crop yield, sugar percentage and recoverable sugar per acre were taken as above ground parameter. Yield determination were made and quality analysis was performed at American Crystal Sugar Quality Tare Lab, East Grand Forks, MN. The soil available nitrogen was determined for 0-

6” depth at the end of the season. Soil available nitrogen at the time of harvest and at the end of the season was also considered as the soil health parameter.

Growth was closely observed for all treatments. The average air temperature was 60.67˚F and 54.48˚F for Downer and Ada respectively. The total rainfall received was 17.26 inches and 10.816 inches for Downer and Ada respectively (NDAWN, April-September 2018). The amount of the rainfall were below average during early growing season for both of the sites (Figure 1 and 2).

Table 1. Initial soil nutrient concentration and basic soil physical-chemical properties

Project	Depth(inch)	NO_3-N (lb/ac)	Olsen-P (ppm)	K (ppm)	PH	OM%
Downer, MN	0-6"	8	5	74	8.1	2.6
	6-24"	15				
	0-24"	23				
Ada ,MN	0-6"	8	5	67	8.4	2.4
	6-24"	12			8.5	
	0-24"	20				

RESULTS

Sugarbeet yield and quality in response to cover crop were presented in Table 2. Average stand count plant population at Downer was low compared to Ada. Average yield at Downer 17.7 tons/acre was lower than average yield at Ada 37.6 tons/ac due to the lack of moisture at early growing season and possible herbicide carryover from the previous growing season at Downer.

Table 2: Effect of different inter-seeded cover crops on sugar beet yield, sugar quality and recoverable sugar/acre and ANOVA results for effect of cover crop species, planting date and inter-seeding on sugar beet root yield and quality parameters

Site	Planting time	Treatments	Yield (tons/ac)	Sugar %	RSA
Downer		Control	18.42±3.27 AB	14.28±0.25 D	4910±929 AB
	June	Rye	18.94±5.29 AB	15.25±0.48 A	5445±1640 AB
		Camelina	21.12±3.84 A	14.80±0.08 ABC	5848±1011 A
		Austrian pea	16.08±5.33 AB	14.70±0.42 BCD	4433±1551 AB
		Mustard	14.51±6.69 B	14.80±0.22 ABC	4050±1882 B
	July	Rye	16.17±3.51 AB	15.08±0.40 AB	4553±1028 AB
		Camelina	17.52±3.23 AB	14.58±0.26 CD	4791±951 AB
		Austrian pea	16.87±2.99 AB	14.35±0.13 CD	4511±783 AB
		Mustard	19.31±1.27 AB	14.68±0.70 BCD	5301±512 AB
		LSD(p=0.05)	6.05	0.46	1723
Ada		Control	37.64±1.39 ABC	16.20±0.35 C	11562±500 BC
	June	Rye	36.12±2.28 C	16.55±0.17 AB	11386±667 C
		Camelina	37.03±2.27 BC	16.65±0.06 AB	11757±439 ABC
		Austrian pea	36.30±3.03 C	16.83±0.36 A	11657±990 BC
		Mustard	39.04±3.10 A	16.62±0.26 AB	12354±1066 A
	July	Rye	38.13±2.04 AB	16.62±0.33 AB	12062±824 AB
		Camelina	38.25±1.89 AB	16.45±0.33 BC	11957±795 ABC
		Austrian pea	38.42±1.03 AB	16.40±0.35 BC	11996±500 AB
		Mustard	37.08±2.47 BC	16.80±0.23 A	11860±891 ABC
		LSD(p=0.05)	1.72	0.34	605
Downer, MN					
Planting Time			NS	**	NS
Species			NS	**	NS
Planting Time*Species			NS	NS	NS
Ada, MN					
Planting Time			*	NS	NS
Species			NS	NS	NS
Planting Time*Species			**	**	*

Means within a column sharing a letter are not significantly (p=0.05) different from each other
*, ** and NS represent significance at 0.1, 0.05 and non-significant respectively

At both sites, yield and quality parameters had significant response to cover crop treatment. At Downer, the lowest sugarbeet yield was observed with mustard interseeded in June and the highest value was observed with camelina interseeded in June. At Ada, mustard interseeded in June had the highest yield and the lowest yield was observed under with rye interseeded in June.

At Downer, the highest sugar content was observed with rye interseeded in June and the lowest under control (no cover crop) . At Ada, the highest sugar content was observed with Austrian pea interseeded in June and the lowest sugar content was observed with treatment with no cover crop. The result shows that sugar content was significantly influenced by the cover crop treatment. It can be hypothesized that cover crop nitrogen uptake might reduce the soil N availability and helped in more sugar accumulation at later growth stage.

At Downer, sugar content was significantly influenced by planting time and cover crop species. The sugar content were higher for the June compared to interseeding in July. Among the cover crop species, interseeding with rye treatment had the highest sugar content and the lowest sugar content was observed under interseeding with pea.

At Ada, planting date and its interaction with cover crop species had significant effect on yield. The average yield were higher for the July interseeded cover crops than for June planted cover crops. Interaction between planting time and species also had significant effect on sugar content and recoverable sugar per acre.

Table 3: Effect of seeding date and inter-seeded cover crop on soil nutrient availability for 0-6' depth at the time of harvest and ANOVA results for effect of cover crop species, planting date and inter-seeding on soil nutrient availability for 0-6' depth at the time of harvest

Site	**Planting time**	**Treatments**	**NO_3-N**	**P (ppm in soil)**	**K (ppm in soil)**
Downer	Control	No cover crop	2.32±0.20 b	14.97±1.76 ab	81.00±14.45 a
	June	Rye	2.06±0.28 b	14.20±0.47 ab	83.75±13.07 a
		Camelina	2.41±0.44 b	12.45±1.12 ab	108.50±42.25 a
		Austrian pea	2.68±0.73 ab	15.48±2.69 a	115.75±38.91 a
		Mustard	2.48±0.51 b	12.72±2.56 ab	111.50±40.64 a
	July	Rye	2.56±0.45 ab	12.95±3.02 ab	84.25±17.40 a
		Camelina	2.29±0.36 b	14.90±5.01 ab	103.00±31.37 a
		Austrian pea	2.00±0.13 b	13.02±1.29 ab	126.75±35.61 a
		Mustard	3.22±1.16 a	11.87±1.45 b	113.00±36.18 a
Ada	Control	No cover crop	3.12±0.74 abc	11.57±5.49 a	103.50±40.25 ab
	June	Rye	3.11±1.35 abc	5.99±0.59 b	83.00±8.37 ab
		Camelina	3.51±1.22 ab	9.96±2.11 ab	98.25±34.62 ab
		Austrian pea	2.17±0.38 c	7.97±2.87 ab	108±58.59 ab
		Mustard	3.89±1.63 a	10.02±8.17 ab	79.00±10.68 ab
	July	Rye	3.49±0.92 ab	5.28±1.64 b	121.25±24.50 a
		Camelina	2.98±0.78 abc	8.24±1.42 ab	77.50±15.72 b
		Austrian pea	3.10±1.09 abc	7.80±3.59 ab	86.50±18.21 ab
		Mustard	2.72±0.60 bc	8.21±4.53 ab	118.50±43.65 ab
Downer, MN					
Planting Time			NS	NS	NS
Species			NS	NS	NS
Planting Time*Species			**	NS	**
Ada, MN					
Planting Time			NS	NS	NS
Species			NS	NS	NS
Planting Time*Species			*	NS	NS

Means within a column sharing a letter are not significantly (p=0.05) different from each other
*, ** and NS represent significance at 0.1, 0.05 and non-significant respectively

Soil nutrient availability for 0-6' depth at the time of harvest, for the sites are summarized in the Table 3. In both sites soil nutrient availability had significant response to the cover crop treatment. But there was no significant interaction or differences among the planting time and cover crop species. At Downer soil nitrate and potassium was significantly influenced by the interaction between planting time and species. For Ada, only soil nitrate was influenced by the interaction between planting time and cover crop species.

CONCLUSION

Interseeding with cover crop had shown some interaction with sugar content. It would be interesting to conduct this trial for multiple site-year to ascertain the interaction among weather and site characteristics and cover crop interseeding.

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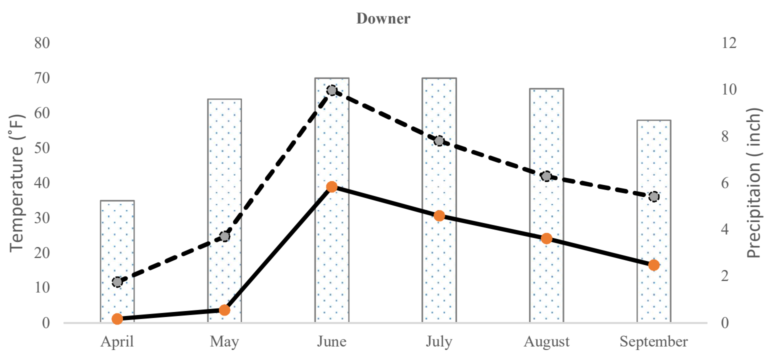

Figure1: Monthly average air temperature and total rainfall of experimental site Downer. April-September 2018, NDAWN

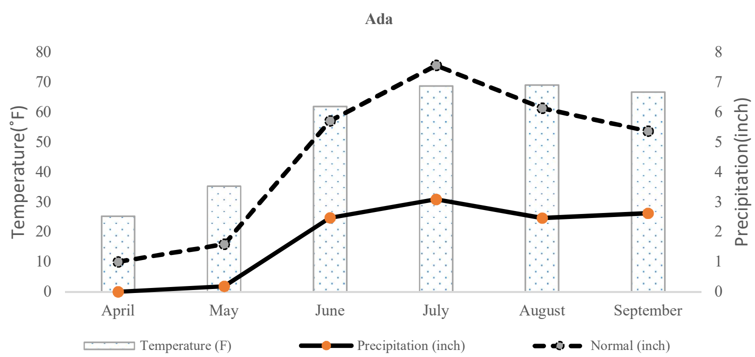

Figure 2: Monthly average air temperature and total rainfall of experimental site Ada. April-September 2018, NDAWN

SUGARBEET
PHYSIOLOGY / STORAGE / PRODUCTION PRACTICES / ECONOMICS

NOTES

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 is 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 if 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.

Summary of Literature: Plant tissue analysis is being utilized more as a tool to determine whether nutrients should be applied in-season to maximize yield of crops. Plant analysis is only suggested for use for diagnosing problems that may occur in field (Kaiser et al., 2013). Fertilizer decisions should be made using soil samples which have been correlated and calibrated to crop response. Never the less, samples are being taken in fields and are being used to sell products which are likely not needed. Databases for "sufficient" levels for nutrients have been developed for use in diagnosing problem areas within fields (Bryson et al., 2014). It is not known whether these sufficiency values were generated using crop response data that documents that yield will be reduced when tissue concentrations are below the stated sufficiency level. It is more likely that the sufficiency values used currently for nutrients such as sulfur or boron are developed based on tissue concentration averages for plots where either nutrient was added but no yield response was achieved. Since both boron and sulfur can be taken up by plants in excess quantities, utilizing averages values of fertilized plots can result in the development of sufficiency ranges that are higher than what would actually be required for maximum crop yield. Most of the research previously cited has shown the effects of boron or sulfur on petiole or leaf blade boron or sulfur concentration the works have not taken the next step in correlating it to crop yield.

Understanding potential sources of variation is important when interpreting plant tissue analysis results. One major source of variation can be differences in uptake patterns among hybrids or varieties. In Minnesota, unpublished survey data for corn and soybean and published data for hard red spring wheat (Kaiser et al., 2014b) found significant variation among hybrids/varieties for a majority of the nutrients analyzed. For the wheat trials, the majority of the variation in nutrient concentration across locations could be attributed to when the samples were collected and the stage of development of the plant at the time of sampling. For all crops the variation in yield could not be explained by one or more nutrients measured in the plant tissue. For sulfur, data collected from multiple crops has noted differences in the amount of sulfur reported in plant tissue based on how the samples are analyzed in the lab (Sterrett et al., 1987). These sources of variation indicate that varieties may have their own sufficiency range for nutrients and that ranges need to be developed based on specific laboratory methods used to determine the concentration of nutrients in plant tissue.

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 and tissue analysis samples was 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 will be sampled at once then separated for individual analysis. All samples were dried, ground, and analyzed for nitrate N 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, and Zn and for pH, soil organic matter, and cation exchange capacity (CEC). 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, 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. Results for chemical soil tests for samples collected from each location at the time samples were collected are summarized in Table 2a and 2b.

Root yield, sugar content per ton, and sugar content produced per acre varied among the six varieties across all four 2017 (Table 3a) and 2017 (Table 3b) locations. The four site average for each of the variables is given in Tables 3a and 3b. However, analysis indicated a significant interaction between site and variety for each year providing evidence of variation in the ranking of varieties among the sites. Overall, root yield, sugar content, and sugar production followed anticipated patterns based on past varietal response data, but variety rankings did slightly vary by year. 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) Root yield and quality did vary allow for correlation between yield and quality and plant tissue concentration.

Results for the analysis of variance for leaf blade tissue concentration are summarized across locations and years in Table 4. The effect of time and variety was significant for all nutrient concentrations. Nutrient concentrations differed among locations except for calcium, magnesium, sulfur, and zinc which did not differ based on location. The location by time interaction was significant for nearly all nutrients except for nitrate-N, calcium, magnesium, and zinc. The time by variety and the three-way interaction of time x location x variety was mostly not significant. The exceptions for the location by variety interaction were total nitrogen, potassium, sulfur, boron, copper, and chloride where the two-way interaction was significant. The three-way time by location by variety interaction was significant for total nitrogen, potassium, sulfur, copper, and manganese. Similar results were found for petiole concentration (Table 5).

Differences in leaf blade nutrient concentration among varieties, when averaged across time and location, are summarized in Table 6. 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 Bryson et al., 2014. 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 6 but there is no given sufficiency ranges for these nutrients. Effects on all nutrient concentrations were similar for petioles (Table 7) 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. Mobile nutrients (N, P, Ca, Mg) exhibited a general decrease in concentration for both leaf blade and petiole tissue over time except for potassium where the leaf blade tissue was relatively unchanged over time and the petiole potassium concentration decreased. The opposite effect was found for immobile nutrients (B, Cu, Mn, and Zn) where concentration increased over time. 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. 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.

Simple correlation between individual nutrient concentration in the leaf blade and petiole at each sampling time and sugarbeet root yield is summarized in Table 8. There were significant positive and negative correlations among many of the nutrients studied. The only nutrient which consistently showed little to no correlation with root yield was tissue phosphorus concentration. There was not instance where a single nutrient always showed a positive correlation with root yield. For example, total nitrogen content in the leaf blade and petiole was positively correlated with root yield at T1 but was not correlated by T3. The greatest correlation was between leaf blade total N at T1 and root yield (r=0.79) which was similar to the correlation between root yield and petiole total N concentration. The next strongest correlation was a negative relationship between leaf and petiole calcium concentration and root yield at T3 and leaf blade total phosphorus concentration at T1.

Table 9 summarizes the correlation between plant tissue and sucrose content and Table 10 summarizes correlation with sugar production per acre. Similar to root yield, there were no instances where sugar content or yield showed a consistent correlation with multiple nutrient. 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 nutrient 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.

Correlations between individual nutrient concentrations and their respective soil test collected at the time of tissue sampling are summarized in Table 11. Significant positive correlations were found between soil test N (along with Nitrate-N), P, and K with leaf blade and petiole N, P, and K, respectively. The strongest correlations were for the 0 to 6-inch depth but significant positive correlations were also found between tissue N and K and the 6-24 inches N and K soil test values. For micronutrients, there were not significant correlations between leaf blade and petiole micronutrient concentrations. Since the sites were maintained at high fertility levels it is not surprising that there was little correlation between soil test values and tissue nutrient concentration for micronutrients. Environmental factors such as temperature and precipitation and crop development at sampling have been shown to influence variation in nutrient concentration among research sites for other crops.

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 (1 week or greater) or short term (less than 1 week) 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.

Long term climatic effects explained over half of the variation leaf blade total N concentration and leaf blade and petiole total Cl concentration. There were more consistent effects for short term climatic factors. Soil test and other soil factors seldom explained a significant amount of variation in specific tissue nutrient concentrations followed by the time factor.

Conclusions: The data presented in the reports if for the first and second year of a three-year study assessing the variation in tissue nutrient concentration among sugar beet varieties. 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 mobile nutrients will decrease while the concentration of most immobile nutrients will increase 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. Data outlining a single sampling time is warranted to narrow down sufficiency levels for most nutrients. 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.

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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	23	60	18
LL	8-May	21-Jun	12-Jul	2-Aug	Nicollet	A Hapludoll	33.7	28.7	35	33	33
M	29-Apr	21-Jun	12-Jul	2-Aug	Bearden-Quam	Ae Calciaquoll	28.0	22.2	15	45	40
R	6-May	21-Jun	11-Jul	1-Aug	Chetomba	T Endoaquoll	31.1	24.4	28	38	35
					2018						
CC	17-May	27-Jun	18-Jul	14-Aug	Bearden-Quam	Ae Calciaquoll	30.9	20.9	15	48	38
H	10-May	21-Jun	9-Jul	2-Aug	Crippin	A.P. Hapludoll	35.8	28.5	10	48	43
LL	7-May	21-Jun	9-Jul	2-Aug	Nicollet	A Hapludoll	31.3	23.7	28	38	35
M	18-May	27-Jun	16-Jul	14-Aug	Bearden-Quam	Ae Calciaquoll	35.2	28.2	8	50	43

‡A, aquic; Ae, aeric; A.P., aquic pachic; T, typic

Table 2a. Summary of 2017 soil test results for samples collected with plant tissue samples at Clara City (CC), Lake Lillian (LL), Murdock (M), and Renville (R).

					Ammonium Acetate				DTPA								
Time	Location	Depth	NO_3-N	P	Ca	K	Mg	SO_4-S	Cu	Fe	Mn	Zn	B	Cl	O.M.	pH	CCE
		in	ppm												-%-		-%-
1	CC	0-6	17.5	12	5852	242	832	12	1.0	7.8	18.1	2.7	1.2	11.2	7.0	7.9	27
		6-24	11.5	3	5058	153	1076	10	1.4	10.0	7.2	0.6	0.8	11.6	4.0	8.1	28
	LL	0-6	31.0	36	4833	182	562	15	1.0	43.8	29.5	0.9	0.6	8.6	6.2	7.0	0
		6-24	17.2	8	4679	153	548	11	1.2	43.5	17.3	0.6	0.6	8.6	4.7	7.0	2
	M	0-6	9.3	8	5960	189	696	12	1.0	7.1	18.6	1.9	1.6	7.8	5.3	8.0	32
		6-24	14.0	2	6330	163	869	133	1.2	6.4	8.0	0.8	1.0	6.7	3.1	7.8	31
	R	0-6	6.9	8	5152	348	583	12	1.4	17.2	29.9	1.6	0.9	9.6	5.1	7.5	2
		6-24	6.9	3	5581	217	608	8	1.4	9.2	11.3	0.5	0.6	7.7	3.1	7.9	11
2	CC	0-6	12.6	12	5938	249	817	11	1.0	7.3	14.7	2.7	1.3	6.9	6.6	8.0	28
		6-24	3.4	3	5139	134	1016	10	1.5	8.2	7.4	0.8	0.7	7.8	4.3	8.2	34
	LL	0-6	16.4	35	4772	156	523	14	1.0	36.0	26.4	0.8	0.5	6.7	6.0	7.3	3
		6-24	4.4	4	4480	138	543	10	1.3	40.7	16.3	0.4	0.5	6.9	4.2	7.1	0
	M	0-6	3.5	9	5877	163	657	11	1.1	7.6	15.3	1.9	1.5	8.0	5.2	8.1	33
		6-24	3.0	3	6824	155	717	160	1.2	6.2	7.6	0.8	1.1	6.8	3.5	7.8	32
	R	0-6	3.4	9	5126	316	537	11	1.3	12.1	24.0	1.4	0.8	9.0	5.2	7.7	1
		6-24	1.6	2	5280	147	693	6	1.4	8.2	8.2	0.3	0.6	9.8	2.9	8.0	10
3	CC	0-6	4.5	16	5957	214	801	11	1.0	8.0	14.0	2.8	0.9	8.6	6.6	8.0	29
		6-24	7.1	2	4835	138	1004	9	1.6	7.6	4.5	0.8	0.6	5.7	3.1	8.2	38
	LL	0-6	4.3	34	4718	142	545	14	1.1	39.6	23.3	1.0	0.6	7.6	6.2	7.3	0
		6-24	1.6	8	3552	135	550	12	1.2	46.0	20.7	0.4	0.7	7.4	4.7	6.8	0
	M	0-6	3.5	7	5943	169	667	11	1.3	6.2	13.4	2.0	1.2	7.1	5.2	8.1	34
		6-24	2.9	3	6236	156	723	61	1.3	5.8	6.5	1.0	1.1	7.5	3.5	7.9	30
	R	0-6	3.4	8	5034	312	558	11	1.4	15.0	22.6	1.4	0.8	8.6	5.2	7.6	1
		6-24	1.7	3	5539	188	688	8	1.4	10.0	10.0	0.4	0.6	8.4	3.2	7.8	6

CCE, calcium carbonate equivalency.

Table 2b. Summary of 2018 soil test results for samples collected with plant tissue samples at Clara City (CC), Hector (H), Lake Lillian (LL), and Murdock (M).

					Ammonium Acetate				DTPA								
Time	Location	Depth	NO_3-N	P	Ca	K	Mg	SO_4-S	Cu	Fe	Mn	Zn	B	Cl	O.M.	pH	CCE
		in	ppm												-%-		-%-
1	CC	0-6	4.9	10	8309	158	467	149	0.7	4.3	18.2	1.8	1.5	9.6	6.7	7.6	37
		6-24	4.3	2	9711	78	660	184	1.1	5.6	6.5	0.6	0.7	9.8	3.3	7.6	38
	H	0-6	14.0	9	6440	208	492	5	1.2	5.9	22.8	0.9	1.3	15.8	6.2	7.7	3
		6-24	9.9	2	5469	99	558	3	1.9	5.9	5.5	0.5	0.6	15.9	3.0	7.9	12
	LL	0-6	10.7	18	5262	200	556	6	0.9	10.8	26.6	1.2	0.8	18.4	5.0	7.7	3
		6-24	11.1	3	4783	106	654	7	1.2	7.3	8.5	0.5	0.5	16.6	2.7	7.7	9
	M	0-6	9.2	21	6191	178	807	10	1.1	6.0	17.4	1.6	1.4	14.1	5.7	7.8	8
		6-24	10.1	3	5343	123	1030	7	1.4	5.6	6.2	0.8	1.0	8.4	3.3	8.0	12
2	CC	0-6	4.3	10	7583	164	394	171	0.6	4.4	14.6	1.6	1.8	56.7	7.3	7.6	38
		6-24	5.5	3	13289	68	441	215	0.6	3.3	3.9	0.3	1.0	12.4	4.5	7.7	37
	H	0-6	3.5	8	6190	242	467	4	1.2	5.9	18.5	0.9	1.2	14.0	6.2	7.7	3
		6-24	2.2	2	5495	121	531	3	1.7	5.4	4.4	0.4	0.6	10.6	3.0	7.9	14
	LL	0-6	2.8	15	5189	156	521	6	0.8	10.0	21.9	1.0	0.8	13.0	5.0	7.8	2
		6-24	6.0	2	5194	114	699	4	1.1	7.6	8.4	0.4	0.6	12.6	3.0	7.7	10
	M	0-6	3.2	10	5993	179	780	5	1.0	5.5	11.7	1.5	1.5	12.8	5.6	7.8	8
		6-24	3.2	3	5022	102	944	5	1.3	5.3	3.7	0.7	0.9	34.2	3.0	8.0	15
3	CC	0-6	2.8	9	7018	162	488	79	0.6	4.1	7.3	1.7	1.5	41.7	7.2	7.6	36
		6-24	1.7	2	10821	66	616	121	0.9	3.1	2.6	0.3	0.9	10.7	3.9	7.7	39
	H	0-6	2.1	6	6284	183	478	4	1.2	5.6	12.8	0.8	1.0	16.8	6.3	7.8	4
		6-24	1.0	1	5773	88	565	3	1.7	5.2	3.9	0.3	0.8	19.8	3.4	7.9	10
	LL	0-6	1.9	14	4942	159	543	5	0.9	10.9	19.1	1.1	0.7	7.5	5.1	7.7	3
		6-24	1.1	1	4837	98	682	4	1.0	7.5	6.9	0.3	0.6	11.1	2.9	7.8	8
	M	0-6	2.3	11	5997	150	771	5	1.0	5.3	6.9	1.5	1.2	8.4	5.8	7.9	7
		6-24	1.8	3	5143	118	937	6	1.3	4.7	2.9	0.7	1.0	16.3	3.3	8.1	15

CCE, calcium carbonate equivalency.

Table 3a. Summary of analysis of variance for the main effect of sugarbeet variety by and across 2017 locations. Numbers within rows which are followed by the same letter are not significantly different at $P \leq 0.10$.

	Variety						
Location	Crystal RR018	Maribo 109	Beta 92RR30	Beta 9475	Crystal M579	Crystal M509	*P*>F
--Root Yield (tons/acre) --							
Clara City	26.8a	23.0ab	19.2b	26.6a	26.2a	25.1a	0.06
Lake Lillian	33.6b	29.0c	28.0c	33.9b	35.0b	38.2a	<0.001
Murdock	37.4b	36.7b	33.2c	37.6b	35.5bc	41.7a	<0.001
Renville	32.6b	29.1c	30.0c	34.3ab	35.0a	36.3a	<0.001
Average	32.5b	29.3c	27.8d	33.1b	32.9b	35.4a	<0.001
--Recoverable Sugar (lbs/ton) --							
Clara City	266bc	278ab	272b	272bc	289a	260c	0.01
Lake Lillian	269a	268a	257b	263ab	270a	249c	<0.001
Murdock	294ab	289bc	297ab	288bc	305a	280c	0.04
Renville	285cd	295b	302a	293b	289bc	280d	<0.01
Average	280b	283b	281b	279b	288a	267c	<0.001
--Recoverable Sugar (lbs/acre) --							
Clara City	7130ab	6413bc	5278c	7254ab	7561a	6555ab	0.05
Lake Lillian	9056a	7789b	7185b	8912a	9421a	9526a	<0.001
Murdock	11011b	10614b	9837c	10820b	10832b	11673	<0.01
Renville	9282bc	8590c	9067c	10014ab	10125a	10173a	<0.01
Average	9110a	8300b	7873c	9265a	9489a	9490a	<0.001

Table 3a. Summary of analysis of variance for the main effect of sugarbeet variety by and across 2018 locations. Numbers within rows which are followed by the same letter are not significantly different at $P \leq 0.10$.

	Variety						
Location	Crystal RR018	Maribo 109	Beta 92RR30	Beta 9475	Crystal M579	Crystal M509	*P*>F
			Root Yield (tons/acre)				
Clara City	15.9b	13.6c	18.6a	16.9ab	17.4ab	18.6a	0.01
Hector	27.7c	29.8b	30.1b	31.1b	30.4b	35.8a	<0.001
Lake Lillian	--	--	--	--	--	--	--
Murdock	28.1c	28.0c	27.9c	32.0b	30.8b	35.0a	<0.001
Average	23.9c	23.8c	25.5b	26.7b	26.2b	29.8a	<0.001
			Recoverable Sugar (lbs/ton)				
Clara City	231	235	242	219	239	229	0.12
Hector	247	251	250	251	260	249	0.62
Lake Lillian	257	263	262	260	267	252	0.14
Murdock	265	278	273	263	282	271	0.11
Average	250b	257a	257a	248b	262a	250b	<0.001
			Recoverable Sugar (lbs/acre)				
Clara City	3679bc	3181c	4525a	3721bc	4153ab	4273ab	0.02
Hector	6859c	7478b	7537b	7796b	7915b	8908a	<0.001
Lake Lillian	--	--	--	--	--	--	--
Murdock	7440d	7771cd	7616d	8412bc	8683b	9495a	<0.001
Average	5992c	6143c	6559b	6643b	6917b	7558a	<0.001

Table 4. Summary of analysis of variance for leaf blade nutrient concentration averaged across eight locations from 2017-2018 and three sampling times at each location.

Nutrient	Time (T)	Location (L)	T x L	Variety (V)	T x V	L x V	T x L x V
	--*P*>F--						
Total-N	***	***	***	***	*	**	*
Nitrate-N	*	0.08	0.12	0.14	0.21	0.48	0.57
Phosphorus	***	***	***	***	0.43	*	0.09
Potassium	***	***	***	***	***	*	**
Calcium	0.07	0.22	0.19	0.19	0.32	0.63	0.55
Magnesium	0.07	0.22	0.18	0.18	0.47	0.54	0.55
Sulfur	***	0.17	***	***	**	***	**
Boron	***	***	***	***	***	***	0.11
Copper	***	0.24	***	***	***	*	**
Iron	***	***	***	***	**	0.26	0.33
Manganese	***	***	***	***	***	0.15	**
Zinc	0.45	0.23	0.37	0.44	0.51	0.70	0.69
Chloride	***	***	***	***	0.06	0.08	0.21

†Asterisks represent significance at P<0.05,*; 0.01, **; and 0.001, ***.

Table 5. Summary of analysis of variance for petiole nutrient concentration averaged across eight locations from 2017-2018 and three sampling times at each location.

Nutrient	Time (T)	Location (L)	T x L	Variety (V)	T x V	L x V	T x L x V
	----------	----------	----------	*P*>F	----------	----------	----------
Total-N	***	***	***	***	***	**	***
Nitrate-N	***	***	***	***	***	0.06	*
Phosphorus	**	***	***	***	*	0.38	**
Potassium	***	***	***	***	***	**	**
Calcium	***	0.11	***	***	***	***	0.10
Magnesium	*	0.10	0.09	0.12	0.13	0.38	0.36
Sulfur	***	***	***	***	0.45	0.06	**
Boron	***	***	***	***	**	0.30	0.40
Copper	***	***	***	***	0.11	0.38	***
Iron	***	***	***	0.18	***	***	***
Manganese	***	**	***	***	***	**	0.10
Zinc	***	0.20	*	0.49	0.78	0.27	0.68
Chloride	*	***	***	***	0.1	0.27	0.41

†Asterisks represent significance at $P<0.05$,*; 0.01, **; and 0.001, ***.

Table 6. Varietal differences in leaf blade nutrient concentration across eight locations from 2017-2018 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	5.09a	4.72b	4.69bc	4.66bc	4.63c	4.71b	4.3-5.0
Phosphorus	0.49a	0.50a	0.42d	0.44c	0.41d	0.47b	0.45-1.1
Potassium	3.80a	3.63b	3.45c	3.48c	3.57b	3.48c	2.0-6.0
Calcium	0.69	0.77	0.76	0.67	0.68	0.72	0.5-1.5
Magnesium	0.48	0.54	0.58	0.51	0.52	0.53	0.25-1
Sulfur	0.37a	0.35d	0.34e	0.36c	0.35d	0.37b	0.21-0.5
	-----ppm					-----	
Nitrate-N	778	433	649	667	509	561	
Boron	31b	32a	32a	29c	31b	29c	31-200
Copper	39b	46a	39b	37b	45a	36b	11-40
Iron	439ab	342c	435ab	398b	450a	457a	60-140
Manganese	67cd	72b	80a	66d	83a	70bc	26-360
Zinc	43	37	41	40	43	43	10-80
Chloride	2992bcd	3512a	3039bc	3120b	2937cd	2934d	

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

Table 7. Varietal differences in petiole nutrient concentration across eight locations from 2017-2018 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	2.29cd	2.35b	2.41a	2.23de	2.21e	2.35bc
Phosphorus	0.32c	0.40a	0.32c	0.32c	0.30d	0.34b
Potassium	4.25b	4.32b	4.01d	4.16c	4.00d	4.56a
Calcium	0.44d	0.57a	0.51b	0.47c	0.49b	0.59a
Magnesium	0.25	0.27	0.28	0.24	0.24	0.24
Sulfur	0.11b	0.13a	0.11b	0.12b	0.11b	0.12b
	--ppm---					
Nitrate-N	4311c		5315a	4281c	3997c	4777b
Boron	0.23c	0.26a	0.24b	0.24b	0.23c	0.26a
Copper	8.3a	8.5a	7.5b	8.6a	7.4b	8.4a
Iron	295	285	266	257	292	276
Manganese	28c	29b	28c	26d	34a	30b
Zinc	18	19	15	16	16	18
Chloride	4980b		5880a	5742a	5665a	6103a

Table 8. Simple correlation (r) between sugarbeet root yield and leaf blade and petiole nutrient concentration for the newest fully developed leaf sampled 45, 65, and 88 days after planting. Correlation r values when between -0.15 and 0.15 are not considered significant at $P \leq 0.10$.

	N	NO3	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn	Cl
Time 1 Blade	0.79	0.37	0.61	0.05	-0.21	0.26	-0.17	0.33	0.31	0.47	0.03	0.65	-0.30
Time 1 Petiole	0.73	0.39	0.34	0.38	-0.37	0.30	0.10	0.48	0.43	0.19	0.13	0.53	-0.29
Time 2 Blade	0.35	0.08	0.38	-0.32	-0.64	-0.42	-0.03	-0.21	0.58	0.05	-0.41	0.11	-0.15
Time 2 Petiole	0.01	0.19	0.33	-0.53	-0.67	-0.10	0.05	0.01	-0.07	0.12	-0.26	-0.10	-0.31
Time 3 Blade	0.07	-0.13	-0.22	0.13	-0.27	-0.17	-0.16	0.11	-0.27	-0.30	0.12	0.11	-0.09
Time 3 Petiole	-0.26	-0.07	0.03	-0.32	-0.32	-0.18	-0.16	0.14	-0.06	-0.37	-0.05	-0.19	-0.20

Table 9. Simple correlation (r) between sugarbeet sugar content (pounds per ton) and leaf blade and petiole nutrient concentration for the newest fully developed leaf sampled 45, 65, and 88 days after planting. Correlation r values when between -0.15 and 0.15 are not considered significant at $P \leq 0.10$.

	N	NO3	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn	Cl
Time 1 Blade	0.52	-0.09	0.36	-0.11	-0.56	-0.18	-0.46	0.33	0.33	0.05	-0.38	0.49	-0.04
Time 1 Petiole	0.40	0.13	0.31	-0.01	-0.61	-0.07	0.04	0.38	0.45	-0.17	-0.30	0.34	-0.20
Time 2 Blade	0.10	-0.25	0.17	-0.05	-0.38	-0.34	-0.24	-0.14	0.51	0.16	-0.14	0.17	0.22
Time 2 Petiole	0.10	-0.11	0.29	-0.18	-0.50	0.06	0.20	0.18	0.09	0.10	0.06	-0.05	-0.02
Time 3 Blade	0.03	-0.20	-0.33	0.31	0.14	0.08	0.11	0.06	-0.36	0.02	0.45	0.42	0.29
Time 3 Petiole	-0.24	-0.01	-0.24	-0.08	-0.09	-0.02	-0.22	-0.12	-0.28	-0.22	0.21	-0.07	0.23

Table 10. Simple correlation (r) between sugarbeet sugar production (pounds per acre) and leaf blade and petiole nutrient concentration for the newest fully developed leaf sampled 45, 65, and 88 days after planting. Correlation r values when between -0.15 and 0.15 are not considered significant at $P \leq 0.10$.

	N	NO3	P	K	Ca	Mg	S	B	Cu	Fe	Mn	Zn	Cl
Time 1 Blade	0.78	0.24	0.61	0.03	-0.33	0.15	-0.29	0.41	0.34	0.42	-0.08	0.68	-0.25
Time 1 Petiole	0.69	0.31	0.34	0.30	-0.47	0.22	0.08	0.51	0.46	0.10	0.01	0.53	-0.30
Time 2 Blade	0.29	-0.04	0.34	-0.26	-0.64	-0.48	-0.07	-0.21	0.63	0.06	-0.40	0.14	-0.05
Time 2 Petiole	-0.01	0.09	0.33	-0.49	-0.68	-0.10	0.10	0.05	-0.02	-0.10	-0.21	-0.10	-0.25
Time 3 Blade	0.05	-0.19	-0.29	0.21	-0.17	-0.13	0.16	0.12	-0.32	-0.26	0.24	0.21	0.01
Time 3 Petiole	-0.31	-0.09	-0.06	-0.28	-0.28	-0.18	-0.21	0.09	-0.14	-0.36	0.02	-0.18	-0.10

Table 11. Correlation between leaf blade and petiole nutrient concentration across locations and sample time with the soil test concentration for the same nutrient for soil samples collected at 0-6 and 6-24 inch soil depths.

Nutrient	Plant Part	0-6" Soil Test	6-24" Soil Test
Nitrogen	Leaf Blade	0.40	0.57
	Petiole	0.56	0.78
Nitrate-N	Leaf Blade	0.58	0.72
	Petiole	0.57	0.83
Phosphorus	Leaf Blade	0.45	0.32
	Petiole	0.34	0.25
Potassium	Leaf Blade	0.58	0.30
	Petiole	0.44	0.12
Calcium	Leaf Blade	0.27	0.16
	Petiole	0.45	0.27
Magnesium	Leaf Blade	-0.08	0.24
	Petiole	-0.03	-0.08
Sulfur	Leaf Blade	0.01	-0.13
	Petiole	0.21	0.25
Boron	Leaf Blade	0.18	0.41
	Petiole	-0.05	-0.15
Copper	Leaf Blade	0.22	0.17
	Petiole	0.27	0.18
Iron	Leaf Blade	0.10	0.08
	Petiole	0.04	0.02
Manganese	Leaf Blade	0.21	0.13
	Petiole	0.38	0.03
Zinc	Leaf Blade	0.28	0.35
	Petiole	0.03	0.12
Chloride	Leaf Blade	0.06	-0.23
	Petiole	0.25	-0.15

Correlations between -0.40 and 0.40 are not significant at $P \leq 0.10$

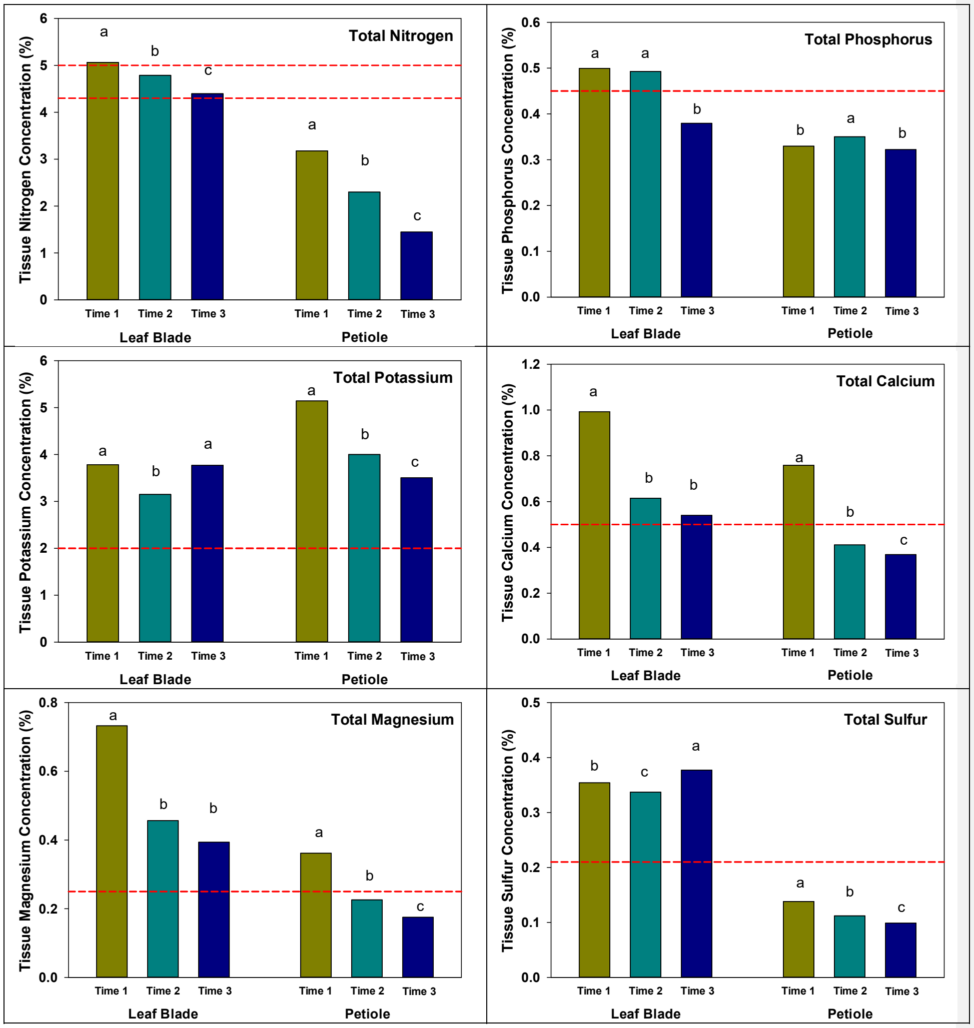

Figure 1. Summary of the impact of time on sugarbeet total macronutrient concentrations for leaf blade and petiole samples collected from six sugarbeet varieties. Letters denote significance among sampling times for leaf blade or petiole samples at $P \leq 0.10$. Horizontal dashed lines represent the 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.

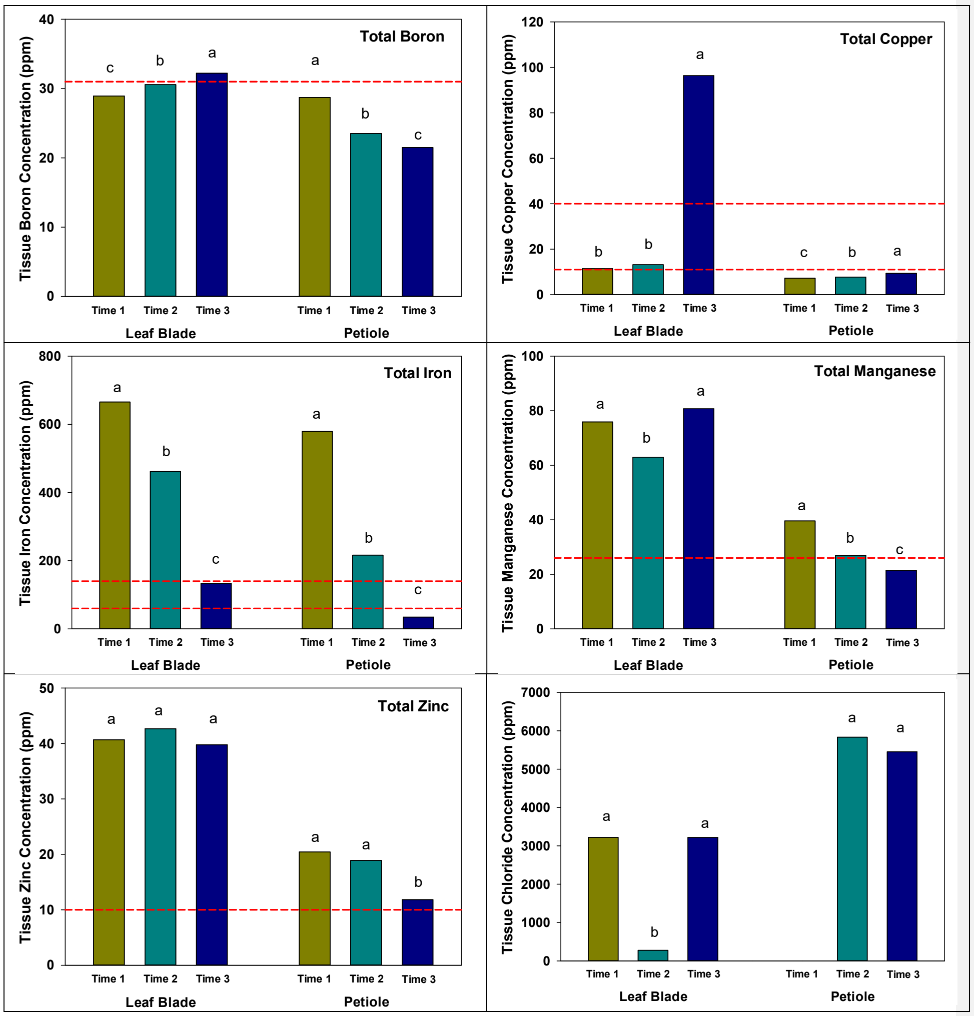

Figure 2. Summary of the impact of time on sugarbeet total micronutrient concentrations for leaf blade and petiole samples collected from six sugarbeet varieties. Letters denote significance among sampling times for leaf blade or petiole samples at $P \leq 0.10$. Horizontal dashed lines represent the 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.

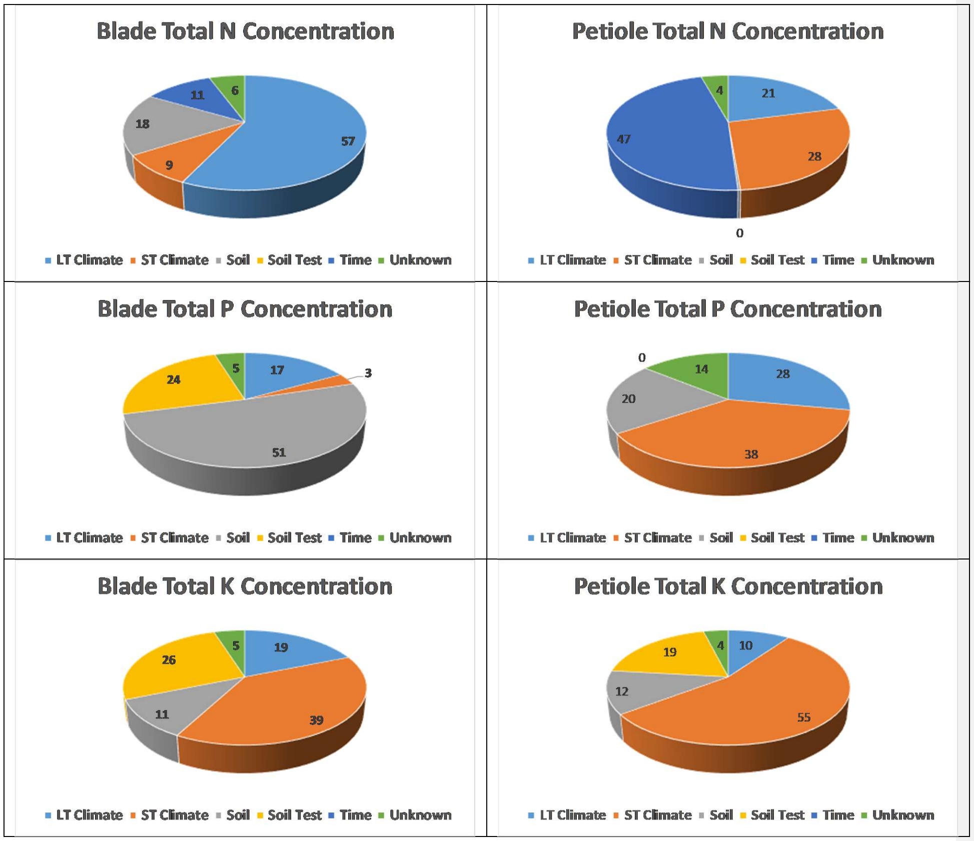

Figure 3. Summary of multiple regression output summarizing climate and soil relationships prediction of sugarbeet primary macro-nutrient concentration. Long term (LT) climate factors represent temperature averages or precipitations total of 1 week or greater while short term (ST) represent totals less than a week. Unknown factors represent the portion of the R^2 not predicted by the model.

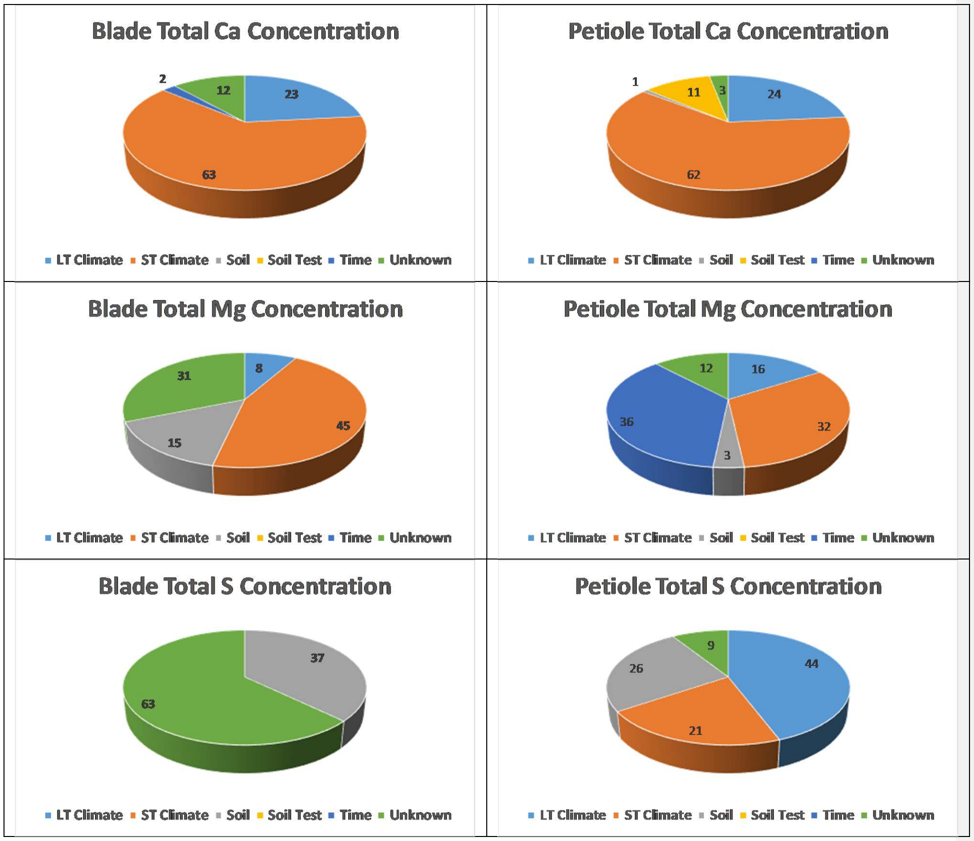

Figure 4 Summary of multiple regression output summarizing climate and soil relationships prediction of sugarbeet secondary macro-nutrient concentration. Long term (LT) climate factors represent temperature averages or precipitations total of 1 week or greater while short term (ST) represent totals less than a week. Unknown factors represent the portion of the R^2 not predicted by the model.

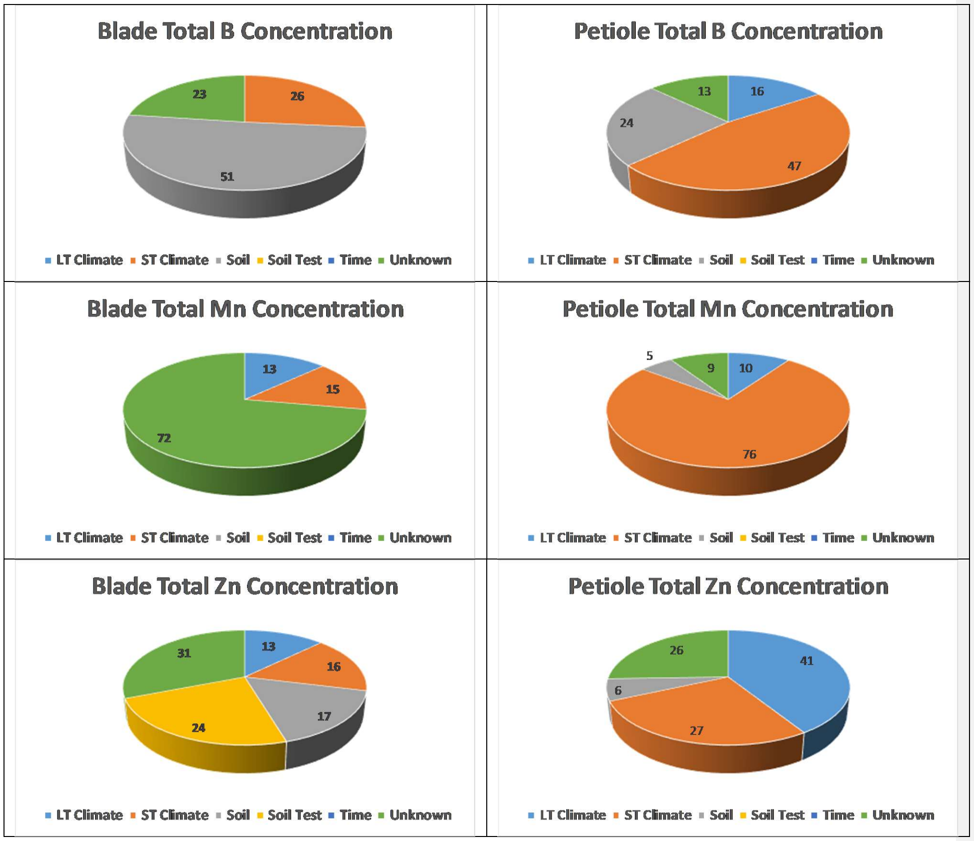

Figure 5. Summary of multiple regression output summarizing climate and soil relationships prediction of sugarbeet micro-nutrient concentration. Long term (LT) climate factors represent temperature averages or precipitations total of 1 week or greater while short term (ST) represent totals less than a week. Unknown factors represent the portion of the R^2 not predicted by the model.

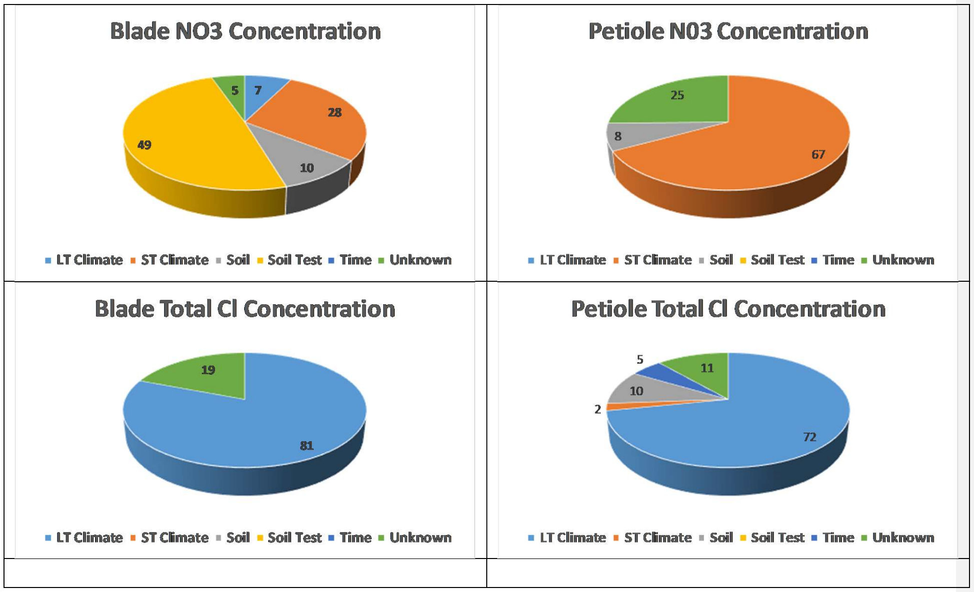

Figure 6. Summary of multiple regression output summarizing climate and soil relationships prediction of sugarbeet nitrate nitrogen and chloride concentration. Long term (LT) climate factors represent temperature averages or precipitations total of 1 week or greater while short term (ST) represent totals less than a week. Unknown factors represent the portion of the R^2 not predicted by the model.

EFFECT OF METHYL JASMONATE AND HEADLINE ON ROOT AND SUCROSE YIELD

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INTRODUCTION

Methyl jasmonate (MeJA) is increasingly investigated for its ability to enhance yield and protect crop plants and products from environmental stress and disease (Rohwer and Erwin, 2008). For many crop species and plant products, MeJA application improves resistance against pathogens and insect pests and provides protection against environmental stresses including cold, drought, and high soil salinity. MeJA also influences plant development, growth, and metabolism, and increases in biomass and alterations in carbohydrate partitioning have been attributed to its use (Pelacho and Mingo-Caster, 1991; Wang and Zheng, 2005). Previous research established that sugarbeets respond to MeJA and documented the ability of postharvest MeJA treatments to reduce rot caused by three storage pathogens (Fugate et al., 2012). The effect of preharvest MeJA treatment on sugarbeet production and storage properties, however, has not been previously studied.

Research to determine the effects of early or late season MeJA treatment on sugarbeet root yield, sucrose content, and storage properties was initiated in 2014. Treatments were applied singly or in combination with a late season Headline treatment. In 2014, Headline was a commonly used fungicide for Cercospora leaf spot (causal agent *Cercospora beticola*) control and was also applied for possible plant health benefits due to purported hormone-like properties (Köhle et al., 2003). Because of the potential of Headline's hormonal effects to interact with MeJA, Headline treatments were included in the experimental design.

In 2014, significant increases in root yield and recoverable sugar per acre were observed for plants that received an early MeJA treatment + a late Headline treatment (Fugate et al., 2016). Plants that received the early MeJA + Headline treatment yielded 3.5 tons acre^{-1} more than untreated controls. Recoverable sugar per acre (RSA) for the early MeJA + Headline treatment was 1856 lbs acre^{-1} greater than the RSA of controls. No significant effects on storage traits including root respiration rate, sucrose loss in storage, invert sugar accumulation, or root firmness were observed due to the early MeJA + Headline treatment.

In a 2015 repetition of this experiment, MeJA had no beneficial effects on root yield, sucrose content, or sucrose yield at time of harvest. The experiment, however, was compromised by a late season Cercospora infection, and Headline-containing treatments outperformed treatments without Headline. An early season MeJA + Headline treatment, however, affected storage traits, and roots that received this treatment had reduced respiration rates after 30 days in storage, reduced loss to molasses after 30 and 90 days in storage, and improved recoverable sugar per ton after 30 days in storage (Fugate et al., 2017).

In 2016 the experiment was again repeated. In this experiment, MeJA treatments had no effect on root yield, sucrose content or sucrose yield at harvest (Fugate et al., 2018). Storage properties were mostly unaffected by MeJA treatment, although an increase in root respiration rate after 100 days in storage for roots that received an early season MeJA treatment and an increase in recoverable sugar per ton after 100 days in storage for roots that received a late season MeJA treatment + Headline were noted.

The experiment was redesigned in 2017 to include only early season MeJA treatments with or without a Headline treatment. To determine if differences in MeJA application time in 2014, 2015, and 2016 were responsible for the variable results between experiments, two application times that differed by approximately 1 month were used. Additionally, a higher rate of MeJA was added to the experiment. The redesigned experiment was repeated in 2018. Results of the 2017 and 2018 field experiments are reported here.

MATERIALS AND METHODS

Field studies were conducted near Mooreton, ND in 2017 and near Foxhome, MN in 2018. Fields were planted to two varieties (Hilleshög 4062 and Betaseed 73MN in 2017 and Hilleshög 4302 and Betaseed 7099 in 2018) using a split plot design with 6 replications and varieties as the main plots. Treatments included (1) an untreated control, (2) a 30-day preharvest Headline treatment, (3) a mid-June MeJA treatment at 0.01 µM, (4) a mid-June MeJA treatment at 10 µM, (5) a mid-July MeJA treatment at 0.01 µM, (6) a mid-July MeJA treatment at 10 µM, (7) a mid-June MeJA treatment at 0.01 µM + 30-day preharvest Headline treatment, (8) a mid-June MeJA treatment at 10 µM + a 30-day preharvest Headline treatment, (9) a mid-July MeJA treatment at 0.01 µM + a 30-day preharvest Headline treatment, and (10) a mid-July MeJA treatment at 10 µM + a 30-day preharvest Headline treatment. MeJA solutions contained 10 ppm (v/v) Tween 20 and were applied as foliar sprays; Headline was applied at a rate of 9 oz/acre. Planting, treatment, and harvest dates for the 2017 and 2018 experiments are reported in Table 1.

At harvest, plants were mechanically defoliated, and roots were unearthed with 1-row (2017) or 3-row (2018) lifters. Harvested roots were washed and stored at 5°C (41°F) and 95% relative humidity for up to 90 days. Respiration rate, sucrose content, loss to molasses, recoverable sugar yield, and invert sugar concentration were determined after 30 and 90 days in storage using established protocols (Campbell et al., 2012).

Data were analyzed by ANOVA with $\alpha = 0.05$ using Minitab Statistical Software (ver. 16; State College, PA). Fisher's LSD was used to identify significant differences between treatment means.

Table 1. Planting, treatment, and harvest dates for the 2017 and 2018 field experiments conducted near Mooreton, ND (2017) and Foxhome, MN (2018).

	2017	2018
Planting date	9 May	11 May
MeJA treatment dates		
June	8 June	14 June
days after sowing	30	34
July	14 July	13 July
days after sowing	66	63
Headline treatments		
date	21 Aug	28 Aug
days before harvest	46	31
Harvest date	6 Oct	28 Sept

RESULTS

In the 2017 field experiment, MeJA treatments had no effect on root yield, sucrose content, loss to molasses or recoverable sugar per ton at time of harvest relative to untreated controls (Table 2). Recoverable sugar per acre (RSA) was similar to controls for all treatments except for a mid-June MeJA application at 0.01 µM with a 30-day preharvest Headline application. This treatment yielded an additional 1149 lbs/acre than the controls.

Storage properties were generally unaffected by MeJA treatments (Tables 3 and 4). After 30 or 90 days in storage, root respiration rate, sucrose content, loss to molasses, recoverable sugar per ton and invert sugar concentration for all MeJA treatments were similar to controls. The only exception was a small decrease in respiration rate after 90 days storage for roots that received a mid-July MeJA application at the 0.01 µM rate.

In the 2018 field experiment, MeJA treatments had no effect on root yield or sucrose content at harvest (Table 5). Further analyses of these root samples to determine loss to molasses and recoverable sugar are ongoing.

Table 2. Harvest data from 2017 field experiment. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05.

Treatment	yield (tons/acre)		sucrose (%)		loss to molasses (%)		Recoverable sugar per ton (lbs/ton)		Recoverable sugar per acre (lbs/acre)	
control--untreated	32.4	ab	16.2	ab	1.58	a	293	a	7993	bc
Headline (HDL)	29.9	b	15.9	ab	1.66	a	285	a	7454	c
Jun MeJA, 0.01 µM	30.1	b	16.2	ab	1.62	a	292	a	7497	c
Jun MeJA, 10 µM	31.4	b	15.8	b	1.49	a	286	a	7644	bc
Jul MeJA, 0.01 µM	32.4	ab	16.3	ab	1.45	a	297	a	8520	ab
Jul MeJA, 10 µM	30.8	b	15.9	b	1.53	a	287	a	7646	bc
Jun MeJA, 0.01 µM	35.4	a	16.4	a	1.18	a	299	a	9142	a
Jun MeJA, 10 µM +	33.4	ab	16.2	ab	1.43	a	295	a	8438	abc
Jul MeJA, 0.01 µM	31.8	ab	16.0	ab	1.46	a	291	a	8045	bc
Jul MeJA, 10 µM +	30.8	b	16.1	ab	1.53	a	291	a	7678	bc

Table 3. Respiration rate and invert sugar concentration 30 and 90 days after harvest (DAH) for the 2017 field experiment. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05. Treatment means that are significantly different from the control are highlighted in red.

Treatment	respiration ($mg\ CO_2/kg/h$) 30 DAH		respiration ($mg\ CO_2/kg/h$) 90 DAH		inverts (g/100 g sucrose) 30 DAH		inverts (g/100 g sucrose) 90 DAH	
control--untreated	4.32	a	3.98	ab	0.61	ab	0.82	a
Headline (HDL)	4.21	a	3.70	ab	0.63	ab	0.79	a
Jun MeJA, 0.01 µM	4.14	a	3.79	ab	0.71	ab	0.79	a
Jun MeJA, 10 µM	4.09	a	3.81	ab	0.73	ab	0.84	a
Jul MeJA, 0.01 µM	4.03	a	3.57	c	0.59	b	0.73	a
Jul MeJA, 10 µM	4.09	a	3.70	ab	0.63	ab	0.81	a
Jun MeJA, 0.01 µM +	4.06	a	4.00	ab	0.63	ab	0.88	a
Jun MeJA, 10 µM +	4.02	a	3.66	bc	0.69	ab	0.76	a
Jul MeJA, 0.01 µM +	4.34	a	4.08	a	0.59	ab	0.84	a
Jul MeJA, 10 µM +	4.19	a	3.89	ab	0.74	a	0.80	a

Table 4. Sucrose content, loss to molasses and recoverable sugar per ton 30 and 90 days after harvest (DAH) for the 2017 field experiment. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05.

Treatment	sucrose (%)		loss to molasses (%)		recoverable sugar per ton (lbs/ton)	
	30 DAH	90 DAH	30 DAH	90 DAH	30 DAH	90 DAH
control--untreated	16.2 abc	16.8 ab	1.56 abc	1.91 ab	292 ab	298 abc
Headline (HDL)	15.9 bc	16.5 ab	1.69 a	1.97 a	285 b	291 bc
Jun MeJA, 0.01 µM	16.1 abc	16.9 ab	1.53 abc	1.97 a	292 ab	298 abc
Jun MeJA, 10 µM	15.9 c	16.4 b	1.67 ab	1.90 ab	284 b	290 c
Jul MeJA, 0.01 µM	16.6 a	17.1 a	1.39 c	1.71 b	304 a	308 a
Jul MeJA, 10 µM	16.1 abc	16.3 b	1.57 abc	1.88 ab	291 ab	289 c
Jun MeJA, 0.01 µM + HDL	16.5 ab	17.1 a	1.47 bc	1.74 ab	301 a	307 ab
Jun MeJA, 10 µM + HDL	16.3 abc	16.8 ab	1.52 abc	1.76 ab	296 ab	300 abc
Jul MeJA, 0.01 µM + HDL	16.3 abc	16.8 ab	1.48 abc	1.76 ab	296 ab	301 abc
Jul MeJA, 10 µM + HDL	16.3 abc	16.9 ab	1.46 c	1.75 ab	296 ab	303 abc

Table 5: Harvest data for the 2018 field experiment. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05. Further analysis of samples is in progress.

	yield tons/acre		**sucrose content** %	
control--untreated	22.0	a	17.8	ab
Headline (HDL)	22.1	a	17.1	b
Jun MeJA, 0.01 µM	21.7	a	17.5	ab
Jun MeJA, 10 µM	20.4	a	17.7	ab
Jul MeJA, 0.01 µM	20.3	a	17.7	ab
Jul MeJA, 10 µM	20.7	a	17.6	ab
Jun MeJA, 0.01 µM + HDL	23.1	a	17.5	ab
Jun MeJA, 10 µM + HDL	21.3	a	18.0	a
Jul MeJA, 0.01 µM + HDL	19.4	a	17.5	ab
Jul MeJA, 10 µM + HDL	21.4	a	18.0	a

ACKNOWLEDGEMENTS

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IMPACT OF CERCOSPORA LEAF SPOT DISEASE SEVERITY ON SUGARBEET ROOT STORAGE

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Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola* (Crous et al., 2001), is the most damaging foliar disease of sugarbeet in North Dakota and Minnesota (Khan and Hakk, 2016). Historically, fungicides have been used to control disease symptoms. However, *C. beticola* has developed tolerance to several fungicides that are used against this disease, increasing the likelihood that disease symptoms will develop during production and that roots harvested from CLS-diseased plants will be incorporated into storage piles.

In Minnesota and North Dakota, sugarbeet roots are stored in ventilated or frozen piles for up to eight months. While other production diseases such as Aphanomyces root rot, Fusarium yellows, rhizomania, and rhizoctonia root and crown rot, are known to have a negative impact on storage (Campbell and Klotz, 2006; Campbell and Klotz, 2008; Klotz and Campbell, 2009; Campbell et al., 2011; Campbell et al., 2014), the effects of CLS on sugarbeet root storage properties are not known. It is suspected that roots harvested from CLS-diseased plants do not store as well as healthy roots. However, the effects of CLS on storage properties such as respiration rate, sucrose loss, losses in recoverable sugar, and the accumulation of invert sugars and other impurities that increase sucrose loss to molasses have not been determined.

Research was initiated in 2018 to determine the impact of different levels of CLS disease severity on sugarbeet root storage properties after short-term and long-term storage. Roots with varying levels of CLS disease severity were obtained from a field that was inoculated with *C. beticola* and contained plots that received variations in fungicide treatments. After field plots were rated for CLS severity, roots from plots with very low, low, moderate, and severe CLS symptoms were harvested and used for evaluating storage properties. These roots are presently in storage, with storage properties to be determined after 30, 90 and 120 days in storage.

MATERIALS AND METHODS

Plants with varying severities of CLS were produced in a field near Foxhome, MN. Six-row plots (11 ft wide by 30 ft long) were planted with Hilleshög 9528 sugarbeet seed on 12 May 2018 using 22-inch rows and 4.7-inch spacing within rows. Plants were produced using recommended agronomic practices (Khan, 2018) and were inoculated with 5 lb ac^{-1} dried *C. beticola*-infected leaves on 28 June 2018. Varying severity of CLS symptoms were obtained using the fungicide treatments described in Table 1, with all fungicides used at their full rates and applied to the middle four rows of each plot. A randomized complete block design with four replicates was used. CLS disease severity was rated using a 1 – 10 scale where 1 indicates an absence of disease symptoms and 10 indicates complete defoliation and leaf regrowth. The middle two rows of each plot were

Table 2: Fungicide treatments and application dates used to obtain plants with varying severity of Cercospora leaf spot symptoms.

Disease Severity	Fungicide Treatment	Application Date
Very Low	Minerva Duo	07/05/18
	Supertin + Topsin	07/18/18
	Proline + Badge SC + NIS	07/31/18
	Mankocide	08/16/18
	Supertin + Manzate	08/31/18
Low	Supertin + Manzate + Topsin	07/18/18
	Supertin + Manzate + Topsin	07/31/18
	Supertin + Manzate + Topsin	08/16/18
	Supertin + Manzate + Topsin	08/31/18
Moderate	Minerva Duo	07/05/18
	Supertin + Topsin	07/18/18
	Proline + Badge SC + NIS	07/31/18
High	untreated	

harvested on 27 September 2018. Roots were washed and roots within a plot were randomly assigned to 10 root samples which served as the experimental unit for the storage study. A 10-root sample from each plot was ground to brei after harvest for the determination of sucrose content, loss to molasses, invert sugar concentrations, impurity concentrations, and recoverable sugar per ton prior to storage. The remaining 10-root samples from each plot were stored at 5°C and 95% humidity in a cold room. Respiration rates of 10-root samples were determined after 30 days in storage using a Licor infrared CO_2 analyzer (Campbell et al., 2011). Additional respiration rate determinations will be made after roots are stored for 90 and 120 days. Following respiration rate determinations, samples were/will be ground into brei. Brei samples will be used for determining sucrose content, loss to molasses, invert sugar concentrations, impurity concentrations, and recoverable sugar per ton after 0, 30, 90, and 120 days in storage.

PROGRESS REPORT

The storage study is currently in progress. Brei samples were collected on the day of harvest and from roots that were stored for 30 days. The sucrose content of these samples has been determined (Table 2) and additional analyses to determine invert content, sodium and potassium concentrations, and amino nitrogen levels are underway. Respiration rate of roots after 30 days storage has also been determined.

At harvest, roots from plants with moderate to severe symptoms had significantly lower sucrose content relative to roots with very low or low CLS symptoms (Table 2). After 30 days in storage, sucrose concentrations for roots from the different disease classifications were similar to those found at harvest with the differences in sucrose content between disease classes at 30 days after harvest (DAH) mirroring the differences that existed at harvest. After 30 days in storage, respiration rate of roots with the four levels of disease were statistically similar.

Table 2: Effect of Cercospora leaf spot severity on sucrose content and storage respiration rate of roots after 30 days in storage. CLS disease severity was rated on a 1-10 scale where 1 indicates an absence of disease and 10 indicates complete defoliation and regrowth of new leaves. DAH = days after harvest. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05. n = 4.

CLS severity class	Disease rating	Sucrose content 0 DAH		Sucrose content 30 DAH		Respiration rate 30 DAH	
		- - - - - - - - (%) - - - - - - -				- - (mg $kg^{-1}hr^{-1}$) - -	
Very low	3	16.0	a	15.8	a	2.48	a
Low	3	15.7	a	15.7	a	2.71	a
Moderate	6	14.1	b	13.6	b	2.41	a
Severe	10	13.7	b	14.0	b	2.76	a

With the limited data available at the time of writing, no evidence has been found to indicate that Cercospora leaf spot affects sugarbeet storage properties. However, this study is not complete and storage properties after 90 and 120 days storage remain to be determined. A full summary of this experiment will be provided in next year's report.

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IMPACT OF DROUGHT STRESS ON SUGARBEET STORAGE PROPERTIES

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Sugarbeet roots in Minnesota and North Dakota are largely produced without irrigation and rely on natural precipitation to meet their water needs. For a large portion of the crop, water stress is, therefore, inevitable when rainfall is insufficient. Drought stress reduces root and sucrose yields, reduces root water content, and increases amino-nitrogen, sodium and potassium concentrations, and sucrose loss to molasses at harvest (Clover et al., 1999; Choluj et al., 2004; Bloch et al., 2006; Hoffmann, 2010). It is expected that drought stress prior to harvest is also detrimental to storage. Information regarding the effects of inadequate water availability during the production season on sugarbeet root storage properties, however, is limited. Kenter and Hoffmann (2008) reported that severely drought-stressed roots accumulated greater concentrations of invert sugars and amino-nitrogen during storage relative to unstressed roots. The effect of minor or moderate drought conditions on these properties, however, is unknown. Because dehydration during storage increases root respiration rate and susceptibility to storage rots (Gaskill, 1950; Lafta and Fugate, 2009), it is likely that preharvest drought stress increases storage respiration rate and the incidence of storage diseases. However, no research has examined the effects of preharvest water stress on postharvest respiration rate or susceptibility to storage diseases.

Research was conducted to investigate the effect of inadequate water availability on sugarbeet root storage properties. Since controlling water availability is difficult with field grown plants due to the unpredictability of rainfall, research was conducted using greenhouse plants. Storage properties evaluated include root respiration rate, sucrose loss, invert sugar accumulation, and susceptibility to storage rots. These investigations are incomplete at the time this report was written. Therefore, all data reported here should be viewed as preliminary.

MATERIALS AND METHODS

Sugarbeet plants were produced in 15 L pots in a greenhouse. Plants were grown with supplemental light using a 16-hour light/8-hour dark regime and were watered with an automated drip irrigation system that delivered 1.0 L water per day to each pot. Watering treatments were created by removing irrigation drip tubes from plants at 0, 1, or 3 weeks prior to harvest to generate plants with no, mild, and severe water stress. Roots from all treatments were harvested 18 weeks after planting, and the harvested roots within a treatment were randomized. On the day of harvest, tissue samples were collected from five replicate roots from each watering treatment. An additional five roots from each watering treatment were stored at 10°C and 90% relative humidity for up to 12 weeks. Six roots from each watering treatment were inoculated with the storage pathogen, *Botrytis cinerea* using the protocol of Fugate et al. (2012). An additional six roots were inoculated with *Penicillium claviforme*. Inoculated roots were stored at 20°C and 90% relative humidity for 28 days.

Respiration rates of individual roots were measured on stored roots after 3, 6, 9, and 12 weeks of storage using the protocol of Haagenson et al. (2006). Tissue samples of these roots were collected after 12 weeks in storage for sucrose and invert sugar determinations. Inoculated roots were assessed for disease progression after 28 days in storage by determining the weight of rotted tissue for each root (Fugate et al., 2012).

PROGRESS REPORT

Restricting water for 1 or 3 weeks prior to harvest caused minor and severe drought stress and reduced the water content of roots harvested from plants that had not received water for 1 or 3 weeks by 1.7 and 6.9%, respectively (Table 1). Storage respiration rates were elevated for roots harvested from severely drought-stressed plants, and roots from the 3-week drought-stress treatment had respiration rates after 3, 6, 9, and 12 weeks in storage that were 2.0, 3.2, 5.2, and 6.2 mg CO_2/kg·h greater than controls, respectively (Table 1). No differences in sucrose concentration that were related to drought stress, however, were noted at harvest or after 12 weeks in storage (Table 2). Sucrose content of roots from all watering treatments, however, declined in storage. The concentration of invert sugars in roots at harvest or after 12 weeks of storage was also not affected by watering treatments, although invert sugar concentrations increased significantly during storage for roots from all watering treatments (Table 2). Susceptibility to two common storage rots was increased by severe water stress. (Table 3). Roots inoculated with *Botrytis cinerea* or *Penicillium* *claviforme* and stored for 28 days had approximately three-fold more rotted tissue than similarly treated roots from well-watered plants.

Table 1: Root water content at harvest and storage respiration rate of roots subjected to drought stress prior to harvest. Water was withheld from plants 1 week or 3 weeks prior to harvest. Controls were watered until the day of harvest. Respiration rate was measured on the same roots after 3, 6, 9, or 12 weeks in storage at 10°C and 90% relative humidity. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05 (n = 5).

Water treatment	Root water content (%)		Respiration rate (mg CO_2/kg·h)							
			3 weeks		6 weeks		9 weeks		12 weeks	
control	77.0	a	3.1	a	2.9	a	5.3	a	8.5	a
1 week	75.3	a	2.5	a	2.6	a	4.3	a	7.9	a
3 weeks	70.1	b	5.1	b	6.1	b	10.5	b	14.7	b

Table 2: Concentration of sucrose and invert sugars at harvest and after 12 weeks in storage of roots subjected to drought stress prior to harvest. Water was withheld from plants 1 week or 3 weeks prior to harvest. Controls were watered until the day of harvest. Roots were stored at 10°C and 90% relative humidity. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05 (n = 5).

Water treatment	Sucrose concentration (mg/g dry wt)				Invert concentration (mg/g dry wt.)			
	at harvest		after storage		at harvest		after storage	
control	441	a	429	a	7.0	a	9.0	a
1 week	440	a	435	a	6.4	a	9.3	a
3 weeks	444	a	425	a	6.5	a	8.3	a

Table 3: Relative weight of rotted tissue in roots subjected to drought stress prior to harvest and inoculated with *Botrytis cinerea* or *Penicillium claviforme* on the day of harvest. Water was withheld from plants 1 week or 3 weeks prior to harvest. Controls were watered until the day of harvest. After inoculation, roots were stored at 20°C and 90% relative humidity for 28 days. Means within a column followed by different letters are significantly different based upon Fisher's LSD, with α = 0.05 (n = 6).

Water treatment	Relative Weight of Rotted Tissue (% of control)			
	Botrytis		*Penicillium*	
control	100	a	100	a
1 week	99	a	85	a
3 weeks	315	b	290	b

ACKNOWLEDGEMENTS

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ENTOMOLOGY

NOTES

TURNING POINT® SURVEY OF SUGARBEET INSECT PEST PROBLEMS AND MANAGEMENT PRACTICES IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2017

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Attendees of the 2018 Winter Sugarbeet Grower Seminars were asked about their 2017 insect pest problems and associated management practices in a live polling questionnaire by using a Turning Point® interactive personal response system. Initial questioning identified the county in which respondents produced the majority of their sugarbeet crop in 2017 (Tables 1, 2, 3, and 4). This report does not include data from the Willmar Seminar because that survey did not include questions on insect pest incidence or insect pest management practices.

Table 1. 2018 Fargo Grower Seminar – survey respondents by county growing sugarbeet in 2017

County	Number of Responses	Percent of Responses
Becker	2	4
Cass	7	14
Clay	11	22
Norman[1]	22	45
Richland	1	2
Steele	1	2
Traill	4	8
Wilkin[2]	1	2
Total	49	

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

Table 2. 2018 Grafton Grower Seminar – survey respondents by county growing sugarbeet in 2017

County	Number of Responses	Percent of Responses
Grand Forks	5	8
Kittson	7	12
Marshall	5	8
Pembina	16	27
Polk	1	2
Ramsey	1	2
Walsh	25	42
Other	0	0
Total	60	

Table 3. 2018 Grand Forks Grower Seminar – survey respondents by county growing sugarbeet in 2017

County	Number of Responses	Percent of Responses
Grand Forks	23	28
Mahnomen	1	1
Marshall	10	12
Polk	35	43
Traill	4	5
Walsh	3	4

Other	5	6
Total	81	

Table 4. 2018 Wahpeton Grower Seminar – survey respondents by county growing sugarbeet in 2017

County	Number of Responses	Percent of Responses
Clay	2	5
Grant	5	12
Richland	10	24
Traverse	2	5
Wilkin	22	54
Total	41	

This report is based on an estimated 143,748 acres of sugarbeet grown in 2017 by 214 survey respondents that attended the Fargo, Grafton, Grand Forks, and Wahpeton Winter Sugarbeet Grower seminars (Table 5). The majority (38%) of respondents reported growing sugarbeet on between 300 and 599 acres during the 2017 production season. An additional 18% produced sugarbeet on 100 to 299 acres, and another 33% grew the crop on a reported range of between 600 and 1,499 acres in 2017.

Table 5. Ranges of sugarbeet acreage operated by respondents in 2017

		Acres of sugarbeet									
Location	Number of Responses	<99	100-199	200-299	300-399	400-599	600-799	800-999	1000-1499	1500-1999	2000+
		--% of responses--									
Fargo	46	4	4	4	22	20	15	9	9	7	7
Grafton	56	4	14	7	20	23	14	5	7	4	2
Grand Forks	72	6	8	10	14	22	12	11	10	1	6
Wahpeton	40	0	12	12	15	15	12	18	10	3	3
Totals	214	4	10	8	17	21	14	10	9	3	4

From a total of 211 respondents at the Fargo, Grafton, Grand Forks, and Wahpeton Grower seminars, 27% reported that the sugarbeet root maggot was their worst insect pest problem during the 2017 growing season (Table 5). The root maggot was reported as the worst insect pest problem by the majority of respondents at both the Grafton (55% of respondents) and Grand Forks (36% of respondents) locations. Other significant insect pest problems reported included springtails (23 and 8% of respondents at Fargo and Grand Forks, respectively), white grubs (19% of respondents at Wahpeton), and wireworms (9, 8, and 7% of respondents at Fargo, Grafton, and Grand Forks, resp.).

Table 6. Worst insect pest problem in sugarbeet in 2017

Location	Number of Responses	Springtails	Cutworms	Lygus bugs	Wireworms	Root maggot	White grubs	None
		--% of responses--						
Fargo	44	23	7	0	9	7	5	50
Grafton	51	2	0	2	8	55	2	31
Grand Forks	75	8	3	1	7	36	4	41
Wahpeton	41	0	5	0	0	0	19	76
Totals	211	8	3	1	6	27	7	47

Most of the seed treatment insecticide use in sugarbeet in 2017 was reported by grower attendees of the Fargo, Grafton, and Grand Forks Winter Sugarbeet Grower Seminars. The majority (54%) of respondents at the Fargo, Grafton, Grand Forks, and Wahpeton seminars indicated that they planted seed treated with Poncho Beta insecticidal seed treatment in 2017, whereas NipsIt Inside and Cruiser seed treatment insecticides were only reported as being used by 10 and 3% of respondents, respectively in 2017 (Table 7). The highest use of Poncho Beta in 2017 was reported by attendees at the Fargo, Grafton, and Grand Forks seminar locations; whereas, the highest use of NipsIt Inside was reported by Grafton and Grand Forks seminar attendees. A relatively large number (33%) of respondents at these events reported that they did not use any insecticidal seed treatment in 2017.

Table 7. *Seed treatment* insecticide use for sugarbeet insect pest management in 2017

Location	Number of Responses	Poncho Beta	Cruiser	NipsIt Inside	None
		--------------------------------% of responses-----------------------------------			
Fargo	36	72	3	6	19
Grafton	48	69	0	14	17
Grand Forks	75	61	4	13	21
Wahpeton	37	3	3	3	92
Totals	196	54	3	10	33

Planting-time granular insecticides were used by an average of 36% of grower attendees of the Fargo, Grafton, Grand Forks, and Wahpeton seminars (Table 8). An overall average of 31% of growers at these meetings reported using Counter 20G at planting time, whereas only 2% of attendees reported applying Lorsban 15G for planting-time protection of their sugarbeet crop from insect pests. Grower-reported use of Counter 20G as a planting-time treatment by Fargo, Grafton, and Wahpeton seminar respondents was at 29, 25, ; whereas 40% of growers at the Grand Forks location reported using Counter 20G at planting to protect their sugarbeet crop. Overall, 63% of respondents across all four grower seminars reported that they did not use a granular insecticide at planting in 2017.

Table 8. *Planting-time granular* insecticides used for insect pest management in sugarbeet during 2017

Location	Number of Responses	Counter 20G	Lorsban 15G	Thimet 20G	Other	None
		--------------------------------------% of responses------------------------------------				
Fargo	42	29	5	2	0	64
Grafton	51	25	4	6	2	63
Grand Forks	78	40	0	0	1	59
Wahpeton	42	24	2	0	2	71
Totals	213	31	2	2	1	63

Averaged across all seminar locations, growers' reported use of Counter 20G to protect their sugarbeet crop in 2017 mostly entailed applying it at either the moderate rate of 7.5 lb product/ac (13% of respondents) or the low labeled rate (5.25 lb product/ac; 11% of respondents), whereas only 7% used Counter at its highest labeled application rate (Table 9).

At the Fargo seminar, although 64% of all growers surveyed indicated that they did not use a granular insecticide material at planting time, the majority (20% of all Fargo respondents; 57% of those that used some form of planting-time granular insecticide) reported using Counter 20G at the 5.25-lb rate. Also, the majority of those surveyed at the Wahpeton seminar (15% of all respondents at this location; 50% of those attending this seminar that used a planting-time granular insecticide) reported using Counter 20G at the low (5.25-lb) labeled rate. Twenty percent of all grower attendees at the Grafton seminar (60% of those that used a granular insecticide at planting) reported using Counter 20G at either its moderate (7.5 lb product/ac; 33% of granule users) or high rate (9 lb/ac; 27% of granule users) in 2017. Similarly, 39% of all grower attendees at the Grand Forks seminar (93% of those that used a granular insecticide at planting) reported using Counter 20G; 54% of Grand Forks grower respondents that used Counter 20G applied it at its moderate rate (7.5 lb product/ac), and 29% of them used the high (9 lb/ac) rate of Counter.

A small number (6%) of growers at the Grafton seminar reported using Lorsban 15G (or generic granular chlorpyrifos product) for planting-time insecticide protection, and all of them chose to apply it at the highest labeled rate of 13.4 lb product per acre. Similarly, only 1% of respondents at the Grand Forks seminar reported using Lorsban 15G (or a generic equivalent) at planting, and all reported using it at its high (13.4 lb/ac) application rate. At the

Wahpeton location, only 6% of respondents reported using Lorsban 15G, and there was an even split (3% each) between growers using it at its low and moderate labeled application rates (6.7 and 10 lb product/ac, respectively).

Table 9. Application rates of *planting-time granular* insecticides used for sugarbeet insect pes management in 2017

Location	Number of Responses	Counter 20G 9 lb	Counter 20G 7.5 lb	Counter 20G 5.25 lb	Lorsban 15G 13.4 lb	Lorsban 15G 10 lb	Lorsban 15G 6.7 lb	Other	None
		--------------------------------------% of responses--------------------------------------							
Fargo	39	3	10	20	0	0	0	3	64
Grafton	47	9	11	6	6	0	0	0	68
Grand Forks	72	11	21	7	0	1	0	1	58
Wahpeton	39	3	5	15	0	3	3	3	69
Totals	197	7	13	11	1?	1	1?	2	64

Although 15% of Fargo grower seminar respondents reported that they applied Mustang Maxx for sugarbeet root maggot management in 2017, most of the postemergence insecticide use for this purpose was reported by growers that attended the Grafton and Grand Forks seminar locations (Table 10). At Grafton, the majority (51%) of respondents indicated that they used either Lorsban Advanced or Lorsban 4E (or a generic liquid form of chlorpyrifos), and an additional 12% reported using Thimet 20G. Similarly, 32% of respondents at the Grand Forks seminar reported using either Lorsban Advanced or Lorsban 4E (or a generic equivalent) for root maggot control. An average of 58% of the respondents across all locations indicated that they did not apply a postemergence insecticide to manage the sugarbeet root maggot. The majority of those respondents were attendees of the Fargo and Wahpeton locations, where a respective 67 and 84% of the respondents reported no use of a postemergence insecticide for root maggot control.

Table 10. *Postemergence* insecticide use for *sugarbeet root maggot* management in 2017

Location	Number of Responses	Lorsban 4E	Lorsban Advanced	Mustang Maxx	Asana	Other liquid	Counter 20G	Lorsban 15G	Thimet 20G	None
		---% of responses---								
Fargo	39	5	0	15	2	0	8	3	0	67
Grafton	49	47	4	4	0	2		2	12	29
Grand Forks	71	25	7	1	1	1	1	0	3	59
Wahpeton	37	0	0	5	3	3	2	0	3	84
Totals	196	22	4	6	1	1	2	1	5	58

Overall satisfaction with insecticide applications carried out for root maggot management was rated as good to excellent by 86% of respondents when averaged across the Fargo, Grafton, Grand Forks, and Wahpeton seminar locations (Table 11). At the Fargo location, 71% of respondents rated their satisfaction with root maggot management efforts as being good to excellent. Similarly, most of the respondents rated their satisfaction with root maggot management practices as being good to excellent at the Grafton and Grand Forks locations (98% and 90%, respectively). Although only 44% of respondents at the Wahpeton seminar rated their satisfaction with performance of root maggot management practices as good to excellent, the same proportion (44%) of those Wahpeton respondents provided an answer of "unsure" on this question. It also should be noted that, as indicated in Table 11, a total of only nine Wahpeton attendees responded to this question.

Table 11. *Satisfaction* with insecticide treatments for sugarbeet root maggot management in 2017

Location	Number of Responses	Excellent	Good	Fair	Poor	Unsure
		---% of responses-----------------------------------				
Fargo	17	53	18	0	6	23
Grafton	43	28	70	0	0	2
Grand Forks	52	63	27	4	0	6
Wahpeton	9	11	33	11	0	44
Totals	121	45	41	2	1	10

Overall, 71% of all respondents at the 2018 Winter Sugarbeet Grower Seminars (all locations combined) reported that their insecticide use in 2017 was not different from what it had been during the previous five years (Table 12). At the Fargo Growers Seminar, 10% of respondents indicated that their insecticide use in sugarbeet had decreased, and 80% of respondents at that location reported no change in insecticide use in comparison to the past five years. However, 15% of grower respondents at both Grafton and Grand Forks indicated that their insecticide use had increased when compared to the previous five years. This finding was probably due to sugarbeet root maggot population increases in 2017 in areas that typically experience lower root maggot infestations. At the Wahpeton seminar location, 10% of respondents reported no change in their insecticide use in 2017 when compared to that of previous years, and 45% indicated that their use of insecticides had decreased in comparison to the previous five years. Attendees at that location also had the highest percentage (43%) of no reported insecticide use in 2017.

Table 12. Insecticide use in sugarbeet during 2017 compared to the previous 5 years

Location	Number of Responses	Increased	Decreased	No Change	No Insecticide Use
		---% of responses-----------------------------------			
Fargo	40	8	10	80	2
Grafton	48	15	4	81	0
Grand Forks	74	15	8	74	3
Wahpeton	42	2	10	45	43
Totals	204	11	8	71	10

At the 2018 Grafton Winter Sugarbeet Growers Seminar, 75% of respondents indicated using some form of online information (e.g., management guide, newsletter article, etc.) or decision-making tool (e.g., root maggot model, app, etc.) for sugarbeet insect pest management planning in 2017 (Table 13). That constituted a 13.6% increase in the use of online insect pest management information in 2017 when compared to 2016 (data from 2016 not shown). The majority (37%) of respondents at the Grafton seminar reported that they used the NDSU sugarbeet root maggot model application on the North Dakota Agricultural Weather Network (NDAWN) website. Grafton seminar attendees' use of other online/electronically delivered information also included the Crop & Pest Report weekly newsletter (12% of respondents), and NDSU's online posting of root maggot fly counts (12% of respondents) for guidance with management decisions. Unfortunately, errors in administration of the Turning Point® survey at Fargo, Grand Forks, and Wahpeton resulted in failures of this question being presented at those locations. As such, no data were collected on this item from those locations.

Table 13. Use of online decision-making tools for sugarbeet insect management in 2017

Location	Number of Responses	NDSU Crop & Pest Report	NDAWN Root Maggot Model	Root Maggot Fly Counts (online)	Root Maggot Mobile App	Other	None
		--% of responses--					
Fargo	NA[1]						
Grafton	49	12	37	12	4	10	25
Grand Forks	NA[1]						
Wahpeton	NA[1]						
Totals		12	37	12	4	10	25

[1]Not available; question inadvertently omitted at Fargo, Grand Forks and Wahpeton due to errors in administration of the Turning Point® survey at those locations

SUGARBEET ROOT MAGGOT FLY ACTIVITY IN THE RED RIVER VALLEY IN 2018

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Sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), fly activity was monitored in multiple grower field sites throughout the Red River Valley (RRV) during the 2018 growing season. The project was jointly funded by the Sugarbeet Research & Education Board of Minnesota and North Dakota and American Crystal Sugar Company. Thirty-four fields were monitored by NDSU, and an additional 47 fields were monitored by agriculturists from American Crystal Sugar Company and the MinnDak Farmers Cooperative.

The Valley-wide average in fly activity for the growing area, 156 cumulative flies throughout the season per trap, was the second-highest in the past 12 years (Figure 1). This suggests that crop advisors and growers should plan to be very vigilant in monitoring fly activity and forthcoming associated media reports to address the anticipated root maggot fly population increases in 2019.

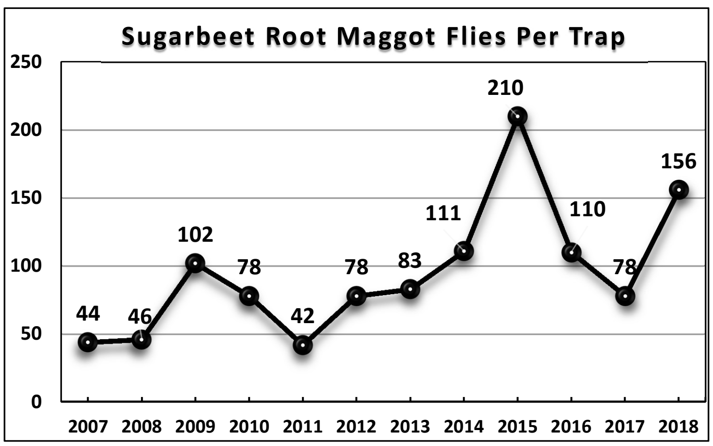

Figure 1. Yearly average capture of sugarbeet root maggot flies in the Red River Valley using sticky-stake traps (Blickenstaff and Peckenpaugh, 1976).

Sugarbeet root maggot fly emergence began unusually early in 2018, and continued at alarmingly high rates for about three weeks. The first flush of high fly activity occurred at several monitoring sites in late May, nearly 3 weeks ahead of the historical average peak fly date. This was the earliest 1st peak in fly activity recorded in the past 20+ years, and it was followed by two additional peaks at multiple sites. The occurrence of two peaks in one growing season is relatively infrequent, but having three peaks in a single season is extremely rare. It is hoped that this was simply an anomaly, and not the onset of a developing new "normal" for SBRM fly activity in the RRV.

The highest levels of SBRM fly activity occurred near the following communities (respective cumulative fly counts per trap for the season within parentheses, in descending order): East Grand Forks, MN (751), St. Thomas, ND (620), Thompson, ND (485), Grand Forks, ND (414), Argyle, MN (380), Drayton, ND (344), Crookston, MN (339), and Fisher, MN (333). Moderately high levels of activity were recorded in 2018 near Cavalier, ND (233), Bowesmont, ND (225), Auburn, ND (222), Bathgate, ND (218), Buxton, ND (182), and Eldred, MN (156). Fly activity in the southern portion of the Valley remained at low to undetectable levels throughout the growing season.

Figure 2 presents SBRM fly monitoring results from three representative sites (i.e., St. Thomas (S. St.

Thomas Township [TWP]), ND, East Grand Forks [Grand Forks TWP], MN, and Thompson (Brenna TWP), ND. The first captures of flies began almost immediately after sticky stakes were deployed (May 23), with relatively high counts being recorded at the first check of stakes on May 25. Significant increases in fly activity occurred during the last couple of days in May, with an additional peak in activity occurring between June 5th and 8th at several sites. Another, albeit, less-significant spike also occurred between June 23 and June 25 at some locations.

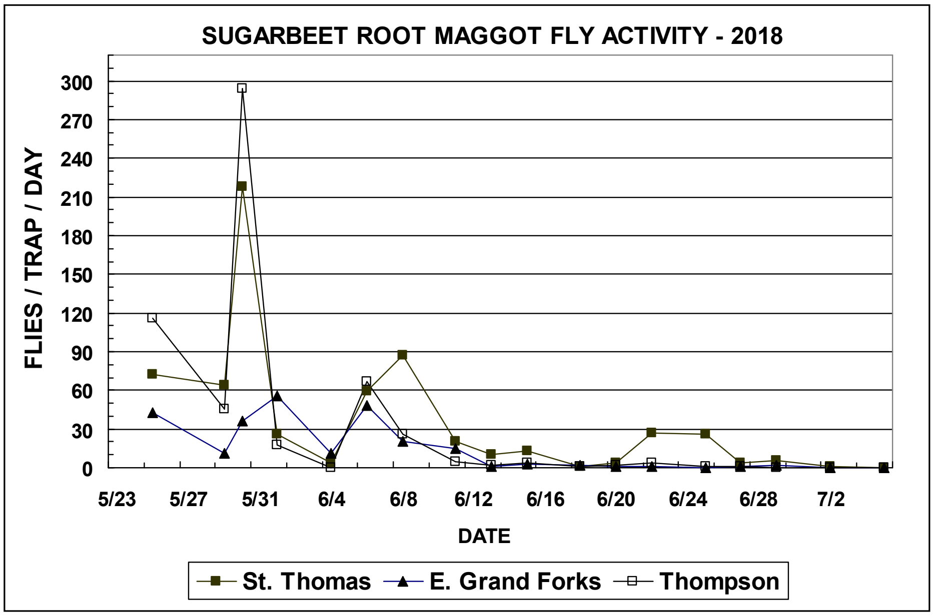

Fig. 2. Sugarbeet root maggot flies captured on sticky-stake traps at selected sites in the Red River Valley.

In late-summer, after the larval feeding period had ended, 56 of the fly monitoring sites were rated for sugarbeet root maggot feeding injury in accordance with the 0-9 scale of Campbell et al. (2000). This is carried out on an annual basis as a means of determining whether fly outbreaks and larval infestations were managed effectively. The resulting data is overlaid with corresponding fly count data to develop a root maggot risk forecast map for the subsequent growing season (the forecast for next year is presented in the report that follows this one).

Root maggot larval feeding injury in most fields was greater than that observed in the past couple of years. The level of root-feeding injury, averaged across all RRV fields that exceeded the generalized economic threshold (43 cumulative flies per trap), was 1.88 on the 0 to 9 scale. That was twice as high as the average feeding injury recorded for above-threshold fields last year (0.94). A list of RRV locations where the highest average root injury ratings were observed is presented in Table 1. Cumulative SBRM fly activity in those fields ranged from 61 flies/trap near Euclid, MN to 485 flies/trap near Thompson, ND.

The comparatively high root injury ratings observed at the locations listed in Table 1 suggests that control efforts in those areas were not as successful as growers may have been hoped. As indicated in the table, root injury ratings in fields near St. Thomas, Thompson, Grand Forks, Cavalier, Reynolds, and Crookston averaged between 3.0 and 5.1, and the remainder were at or above 2.5. This is alarming because it is somewhat rare for root maggot feeding injury ratings in grower fields to exceed 3.0.

Table 1. Sugarbeet root maggot feeding injury in several Red River Valley sugarbeet fields where injury exceeded 2.5, 2018				
Nearest City	**Township**	**State**	**Flies/stake**	**Average Root Injury Rating[a]**
St Thomas	S. Cavalier	ND	228	5.1
St Thomas	S. Midland	ND	no count	4.1
Thompson	Brenna	ND	485	3.8
Grand Forks	Grand Forks	ND	123	3.6
Cavalier	N. Cavalier	ND	233	3.5
Reynolds	Bentru	ND	93	3.2
Grand Forks	Allendale	ND	414	3.1
Crookston	Crookston	MN	339	3.0
Euclid	Euclid	MN	61	2.9
Argyle	Wanger	MN	380	2.8
Bowesmont	Lincoln	ND	225	2.8
Auburn	Martin	ND	222	2.8
St Thomas	Lodema	ND	149	2.6
Thompson	Americus	ND	143	2.5
Crookston	Crookston	MN	255	2.5

[a]Sugarbeet root maggot feeding injury rating based on the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

As such, risk of damaging SBRM infestations in those areas for the 2019 growing season will be high. Careful monitoring of fly activity in moderate- and high-risk areas (see Forecast Map [Fig. 1] in subsequent report) will be critical to preventing economic loss in 2019. Vigilant monitoring and effective SBRM management on an individual-field basis by sugarbeet producers could also help prevent significant population increases from one year to another, because even moderate levels of root maggot survival in one year can be sufficient to result in economically damaging infestations in the following year.

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SUGARBEET ROOT MAGGOT FORECAST FOR THE 2019 GROWING SEASON

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The 2019 sugarbeet root maggot (SBRM) forecast map for the Red River Valley (RRV) is shown in the figure below. The significant increases in fly activity and greater-than-expected root injury observed at several RRV locations last year suggest that root maggot infestations in 2019 are expected to be higher than those in recent years. Areas at highest risk of damaging SBRM infestations include rural Auburn, Bathgate, Bowesmont, Cavalier, Drayton, Grand Forks, Reynolds, St. Thomas, and Thompson, ND, as well as Argyle, Crookston, East Grand Forks, Euclid, and Fisher, MN. Moderate risk is expected in areas bordering those high-risk zones, as well as near Buxton, Cashel, Crystal, and Grafton, ND, and Ada, Eldred, and Fisher, MN. The remainder of the area is at lower risk. Proximity to previous-year beet fields where SBRM populations were high and/or control was unsatisfactory can increase risk. Sugarbeet fields near those where high fly activity occurred in 2018 should be closely monitored in 2019. Growers in high-risk areas should use an aggressive form of at-plant insecticide treatment (i.e., granular insecticide) and expect the need for a postemergence rescue insecticide (i.e., banded granules or peak-fly spray). Those in moderate-risk areas using insecticidal seed treatments for at-plant protection should monitor fly activity levels closely in their area, and be ready to apply additive protection if justified. Any grower in an area with a history of SBRM problems should pay close attention to fly activity levels in late-May through June to decide if postemergence treatment is needed. NDSU Entomology will continue to inform growers regarding SBRM activity levels and hot spots each year through radio reports, the NDSU "Crop & Pest Report", and notification of sugar cooperative agricultural staff when appropriate. Root maggot fly counts for the current growing season and those from previous years can be viewed at: http://www.ndsu.edu/entomology/people/faculty/boetel/flycounts/.

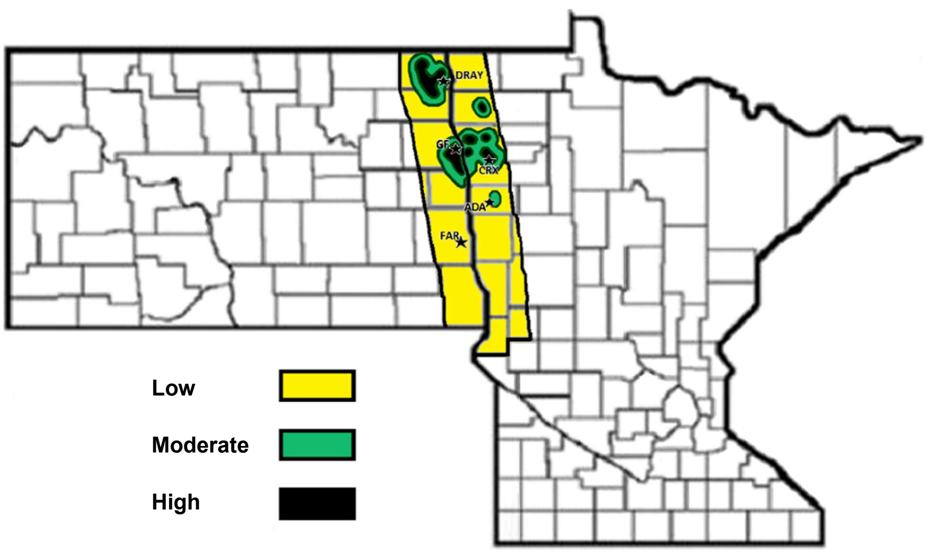

Fig. 1. Anticipated risk of SBRM fly activity and damaging larval infestations in the Red River Valley.

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We appreciate the efforts of the following sugar cooperative agriculturists in monitoring several grower fields for sugarbeet root maggot fly activity, which we believe has added precision to this forecast (presented in alphabetical order): Mike Doeden, Tyler Driscoll, Curtis Funk, Tom Hermann, Austin Holy, Bob Joerger, Holly Kowalski, Brock Larson, Terry Lunde, Chris Motteberg, Travis Pederson, John Samdahl, Dan Vagle, and Chad Wheeler. Thanks are also due to the following NDSU summer aides for providing assistance with fly monitoring activities: Juliana Hanson, Clara Jastram, Rachel Stevens, Claire Stoltenow, Kenan Stoltenow. We also thank the Sugarbeet Research and Education Board of Minnesota and North Dakota, and American Crystal Sugar Company for providing significant funding for this project. This work was also partially supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Hatch project accession number 1012990.

PERFORMANCE OF SINGLE-, DUAL-, AND TRIPLE-COMPONENT INSECTICIDE PROGRAMS UNDER MODERATE AND SEVERE SUGARBEET ROOT MAGGOT PRESSURE SITUATIONS

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Introduction:

Severe infestations of the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), occur on a frequent basis in central and northern portions of the Red River Valley (RRV) of North Dakota and Minnesota. Published research has demonstrated that this pest is capable of causing more than 45% yield losses in the absence of effective control measures (Boetel et al. 2010). High population levels of this pest often require aggressive management programs to ensure adequate protection of the sugarbeet crop. Control programs in areas at high risk of economic loss from this pest usually consist of either a granular insecticide or an insecticidal seed treatment at planting, followed by an additive postemergence insecticide application when the SBRM infestation warrants it. Broadcast applications of sprayable liquid insecticides, applied on an as-needed, rescue basis, are the most commonly used postemergence tools for SBRM control in the RRV. However, the use of postemergence granular insecticide products has increased in recent years. An advantage of postemergence sprays is that growers can use a "wait and see" approach, and make informed decisions on whether rescue insecticide treatments are needed based on current fly activity levels in their fields. This research was carried out to determine the most effective combinations of planting-time and postemergence insecticides to optimize sugarbeet root maggot control under both moderate and severe infestation levels.

This project involved two experiments. The objectives of Study I were to: 1) compare Counter 20G granular insecticide with Poncho Beta seed treatment for at-plant SBRM control; 2) assess the efficacy of combining Poncho Beta with Counter 20G at planting time for a one-pass SBRM control system; 3) determine the impacts of additive postemergence applications of Thimet 20G to plots initially treated with either Counter 20G or Poncho Beta seed treatment for SBRM control; 4) measure the performance of Counter 20G as a postemergence control option; and 5) determine if SBRM control can be maximized by employing a three-component (i.e., seed treatment insecticide + at-plant or postemergence granular insecticide + postemergence liquid spray) management program.

The objectives of Study II were to: 1) measure the impacts of Poncho Beta seed treatment and Counter 20G (at differing application rates) on root maggot control in dual-insecticide programs that include postemergence Lorsban Advanced liquid insecticide spray applications; and 2) assess the effect of application rate on performance of Lorsban Advanced for postemergence root maggot control.

Materials and Methods:

Studies I and II were established on a commercial sugarbeet field site near St. Thomas (Pembina County), ND, and Study II was repeated at a similar field site near Thompson, ND. Betaseed 89RR52 glyphosate-resistant seed was used for all entries in both experiments, and a professional seed preparation company (Germains Seed Technology, Fargo, ND) applied Poncho Beta to seed for all entries that included an insecticidal seed treatment in these trials. Both experiments were planted on 10 May at St. Thomas, and Study II was planted on 15 May at the Thompson location. All plots were planted using a 6-row Monosem NG Plus 4 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. No insecticide was applied to the outer "guard" rows (i.e., rows one and six) of each plot, as those rows served as untreated buffers. Each plot was 35 feet long, and 35-foot alleys between replicates were maintained weed-free throughout the growing season by using tillage operations. Both experiments were arranged in a randomized complete block design with four replications of the treatments at each location.

<u>Planting-time insecticide applications</u>: Counter 20G was applied in both trials by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders.

Granular application rates were regulated by using a planter-mounted SmartBox™ computer-controlled insecticide delivery system that was calibrated on the planter immediately before all applications.

Postemergence insecticide applications: Postemergence insecticides in Study I consisted of two granular materials (i.e., Counter 20G and Thimet 20G) and one liquid spray product (i.e., Lorsban Advanced). Postemergence band-applied granules (Post B) were applied on 31 May at both locations (i.e., 7 days before peak SBRM fly activity at St. Thomas and 5 days pre-peak at Thompson). Band placement of postemergence granules was achieved by using Kinze™ row banders that were attached to a tractor-mounted tool bar and adjusted to a height to deliver the insecticides in 4-inch bands. Similar to at-plant insecticide applications, postemergence granular output rates were also regulated by using a SmartBox™ system mounted on a tractor-drawn four-row toolbar. All postemergence granular applications were incorporated by using two pairs of rotary tines that straddled each row on the tool bar. A paired set of tines was positioned ahead of each bander, and a second pair was mounted behind the granular drop zone of each row unit. This system effectively stirred soil around the bases of sugarbeet seedlings and incorporated granules as the unit passed through each plot.

The postemergence spray applications of Lorsban Advanced in both studies and at both locations were broadcast-applied on 4 June (i.e., about 3 days before peak SBRM fly activity at St. Thomas, and one day pre-peak at Thompson). Sprays were applied from a tractor-mounted CO_2-propelled spray system equipped with an 11-ft boom that was calibrated to deliver a finished spray volume output of 10 GPA through TeeJet™ 110015VS nozzles.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in both studies at St. Thomas on 30 July and in Study II at Thompson on 2 August. At each location, ten beet roots were randomly collected per plot (five from each of the outer two treated rows). Each root was hand-washed and scored in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. Plots for both studies were harvested on 24 and 20 September at St. Thomas and Thompson, respectively. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were extracted from soil using a mechanical harvester, and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

Data analysis: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Study I. Sugarbeet root maggot feeding injury rating results for Study I are presented in Table 1. The level of root injury that occurred in the untreated check plots (mean = 7.9 on the 0 to 9 scale of Campbell et al. [2000]) suggested that a severe SBRM infestation was present at St. Thomas. All insecticide-protected plots had significantly lower levels of SBRM feeding injury than the untreated check, regardless of whether involving a seed treatment, single at-plant granular application, dual-, or triple-application insecticide combination was used for SBRM control.

The lowest overall root injury rating mean (i.e., highest root protection level) in Study I occurred in plots that received the combination treatment comprised of Poncho Beta-treated seed, followed by a postemergence application of Counter 20G at its high labeled rate of 8.9 lb product per acre. Root maggot feeding injury in that treatment was significantly lower than that in all other treatments, except the combination of Counter 20G applied at planting at 7.5 lb, combined with a postemergence application of Thimet 20G at its high rate of 7 lb product per acre. The treatment combination of Poncho Beta seed treatment plus a postemergence application of Counter 20G at its high (8.9 lb product/ac) rate provided significantly greater root protection than the treatment consisting of Poncho Beta plus the same rate of Counter applied at planting time, suggesting that Counter may be a very effective option as a postemergence SBRM control tool.

All dual- and triple-insecticide programs provided significant improvements in root protection from SBRM feeding injury when compared with any single-component program, irrespective of whether the at-plant protection involved Poncho Beta or any rate of Counter 20G. Triple-component programs, consisting of Poncho Beta-treated seed plus either Counter 20G at planting or a postemergence application of Thimet 20G, and followed by a postemergence spray of Lorsban, did not result in improved root protection when compared with similar plots that were not treated with the additional application of Lorsban Advanced. These results suggest that there was no significant improvement in root protection from the postemergence spray of Lorsban Advanced when Poncho Beta was combined with a granular insecticide at either planting or postemergence timing.

Table 1. *Larval feeding injury* in an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence insecticides, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 8.9 lb	68 g a.i./ unit seed 1.8	4.28 e
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	4.73 de
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	4.85 d
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	5.03 cd
Poncho Beta + Thimet 20G	Seed 7 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	5.05 cd
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	5.10 cd
Poncho Beta + Thimet 20G + Lorsban Advanced	Seed 7 d Pre-peak Post B 3 d Pre-peak Broadcast	 7 lb 1 pt	68 g a.i./ unit seed 1.4 0.5	5.10 cd
Poncho Beta + Counter 20G + Lorsban Advanced	Seed B 3 d Pre-peak Broadcast	 8.9 lb 1 pt	68 g a.i./unit seed 1.8 0.5	5.25 cd
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	5.48 c
Poncho Beta	Seed		68 g a.i./ unit seed	6.20 b
Counter 20G	B	8.9 lb	1.8	6.35 b
Counter 20G	B	7.5 lb	1.5	6.43 b
Counter 20G	B	5.25 lb	1.05	6.45 b
Check	---	----	---	7.90 a
LSD (0.05)				0.538

Means within a column sharing a letter are not significantly (*P* = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Post B = postemergence band; Seed = insecticidal seed treatment

Yield data from Study I are presented in Table 2. All insecticide treatments in this experiment, irrespective of whether involving a single at-plant application of Counter 20G or Poncho Beta insecticidal seed treatment or a dual- or triple-component insecticide program, resulted in statistically significant increases in recoverable sucrose yield, root tonnage, and percent sucrose content. Although yield increases are common in root maggot control experiments, consistent sucrose content increases such as those observed in this trial are somewhat rare, and likely were a product of the severe SBRM infestation that was present at the St. Thomas location in 2018.

As observed in the SBRM feeding injury data for Study I, trends suggested better performance with dual- and triple-insecticide programs. The top-yielding entry in this study involved Poncho Beta-treated seed, combined with a postemergence application of Counter 20G at its high (8.9 lb product/ac) labeled rate. That entry generated $275/ac greater revenue than plots protected solely by Poncho Beta seed treatment, and a revenue increase of $705/ac over the gross revenue generated by untreated check plots. Other entries that were not statistically outperformed by this treatment in relation to both recoverable sucrose yield and root tonnage included the following: 1) Poncho Beta + Counter 20G applied at postemergence at 5.25 lb/ac; 2) the triple-component program consisting of Poncho Beta seed treatment, combined with an at-plant application of Counter 20G at its high (8.9 lb product/ac) rate and a postemergence spray application of Lorsban Advanced at its moderate (1 pt/ac) rate; 3) Counter 20G applied at planting time + postemergence Thimet at 7 lb product/ac; and 4) Poncho Beta + postemergence Thimet 20G at 7 lb/ac + Lorsban Advanced applied postemergence at 1 pt/ac. These five top-performing treatments generated between $283 and $333/ac more gross revenue than any of the single at-plant protection programs involving either Poncho Beta or Counter 20G, and between $664 and $713/ac more revenue than the untreated check plots. These economic benefits would have easily paid for the product and application costs associated with their use, and provided significant amounts of additional net revenue per acre.

Another finding in yield results that corresponded with root injury rating data was that Counter 20G performed well when applied postemergence. In plots where the high (8.9-lb) rate of Counter was combined with Poncho Beta-treated seed, recoverable sucrose yield and root tonnage were significantly greater than in similar plots where the Counter was applied at the same rate, but at planting time.

Table 2. ***Yield parameters*** **from an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence insecticides, St. Thomas, ND, 2018**

Treatment/ form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 8.9 lb	68 g a.i./ unit seed 1.8	9110 a	30.6 a	16.28 b-e	1075
Poncho Beta + Counter 20G	Seed 7 d Pre-peak Post B	 5.25 lb	68 g a.i./ unit seed 1.05	9106 a	30.6 a	16.38 a-e	1073
Poncho Beta + Counter 20G + Lorsban Advanced	Seed B 3 d Pre-peak Broadcast	 8.9 lb 1 pt	68 g a.i./unit seed 1.8 0.5	9005 a	29.8 ab	16.38 a-e	1083
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	8971 ab	28.7 abc	16.90 ab	1134
Poncho Beta + Thimet 20G + Lorsban Advanced	Seed 7 d Pre-peak Post B 3 d Pre-peak Broadcast	 7 lb 1 pt	68 g a.i./ unit seed 1.4 0.5	8879 ab	30.0 ab	16.15 cde	1038
Poncho Beta + Thimet 20G	Seed 7 d Pre-peak Post B	 7 lb	68 g a.i./ unit seed 1.4	8483 ab	26.9 bcd	17.00 a	1081
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	8351 ab	28.2 abc	16.20 b-e	977
Poncho Beta + Counter 20G	Seed B	 5.25 lb	68 g a.i./ unit seed 1.05	8203 abc	26.4 cd	16.85 abc	1028
Poncho Beta + Counter 20G	Seed B	 8.9 lb	68 g a.i./ unit seed 1.8	7970 bc	25.8 cd	16.68 a-d	988
Poncho Beta	Seed		68 g a.i./ unit seed	7238 cd	25.3 cde	15.85 e	800
Counter 20G	B	8.9 lb	1.8	6946 de	23.7 def	16.10 de	801
Counter 20G	B	7.5 lb	1.5	6473 de	21.9 ef	16.23 b-e	754
Counter 20G	B	5.25 lb	1.05	6148 e	20.4 f	16.33 a-e	735
Check	---	----	---	4208 f	16.6 g	14.45 f	370
LSD (0.05)				1015.4	3.44	0.723	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Post B = postemergence band; Seed = insecticidal seed treatment

In comparing dual- and triple-component SBRM control programs, the addition of Lorsban Advanced (1 pt/ac) to plots initially planted with Poncho Beta-treated seed and treated at planting with Counter 20G at 8.9 lb product per acre resulted in significant increases in both recoverable sucrose yield and root yield (i.e., 1,140 lb and 4.8 tons/ac, respectively). A similar trend occurred when the low (5.25 lb/ac) rate of at-plant Counter 20G was used, but only root tonnage was statistically greater in plots that received the Lorsban Advanced application. The supplemental application of Lorsban Advanced in these comparisons returned $45 to $87/ac in gross revenue over Poncho Beta/Counter 20G plots that did not receive the postemergence spray of Lorsban. In plots initially treated with Poncho Beta and treated at postemergence with Thimet 20G, there was no significant yield benefit from adding a postemergence spray of Lorsban Advanced.

The gross economic return generated by using stand-alone planting-time applications of Counter 20G ranged between $365 and $431/ac, which would have significantly exceeded the treatment cost and provided substantial additional net revenue. The use of Poncho Beta as a stand-alone form of protection generated an increase of $430/ac in gross return, which also would have also easily paid for the cost of the treatment and provided a major increase in net revenue per acre. Although these results demonstrate the economic benefits of at-plant protection against SBRM feeding injury and associated yield/revenue loss, they also clearly demonstrate the economic value of applying an additive insecticide, either in the form of a planting-time insecticide (if insecticide-treated seed is used), or a postemergence insecticide application (regardless of whether the initial at-plant protection consists of a seed treatment or a granular insecticide).

It should be noted that Counter insecticide can only be applied once per year. Therefore, if Counter 20G is applied at planting, it cannot be applied postemergence to the same field. It also bears noting that Counter 20G is now labeled with a 90-day preharvest interval (i.e., PHI, the number of days that must elapse after application before a crop can be harvested) for sugarbeet. This makes Counter a much more feasible product as a postemergence option for sugarbeet root maggot control than it had been in the past, as it previously was labeled with a 110-day PHI. The 90-day PHI should work well for Red River Valley growers choosing to use Counter 20G for SBRM management. Postemergence granule applications for SBRM control in the area are typically most effective if made in late-May to early-June. If this product were to be applied to a field on June 1, the 90-day PHI would expire before September 1, which is typically the earliest that pre-pile sugarbeet harvest operations begin in the Valley.

Study II. This experiment, conducted at both St. Thomas and Thompson, ND, involved evaluations of dual-insecticide programs, comprised of either Counter 20G or Poncho Beta for the planting-time component and Lorsban Advanced (either 1 or 2 pts/ac) as the postemergence component, for SBRM control. Results from evaluations of sugarbeet root maggot larval feeding injury in Study II at **St. Thomas** indicated that a severe SBRM larval infestation was present for this trial. This is supported by the high average root maggot feeding injury rating (i.e., 8.25) recorded for the untreated check plots (Table 3). All insecticide-treated entries provided significant reductions in SBRM feeding injury when compared to that recorded in the untreated check.

The treatment combination of Counter 20G at planting, plus a postemergence application of Lorsban Advanced at its high (2 pts product/ac) rate, was the most effective program at preventing SBRM larval feeding injury at St. Thomas. This combination resulted in significantly lower feeding injury than all other treatments, except the combination of a planting-time application of Counter at 7.5 lb product/ac with a postemergence application of Lorsban at the same (2 pts/ac) rate. In entries that included Counter at planting (both 7.5- and 8.9-lb rates), the use of Lorsban Advanced was more effective at its high (2-pt) rate than the lower (1-pt) rate. It also should be noted that the addition of Lorsban Advanced at the lower rate (1 pt/ac) did not significantly improve root protection in plots initially treated with Counter at either 7.5 or 8.9 lb/ac when compared to corresponding plots that had only received the at-plant Counter application (i.e., no postemergence insecticide).

All four of the top-performing treatments at St. Thomas, with regard to protection from SBRM larval feeding injury, involved using Counter for the at-plant insecticide, including the single application (i.e., no postemergence insecticide) at 8.9 lb/ac. This suggests a slight advantage in root protection by using Counter as the at-plant protection tool. The most important overall trends with regard to root protection in this trial suggest that the rate of postemergence liquid insecticide used is more important for root protection than the at-plant insecticide rate, because there were no rate-related differences between plots that received the 7.5- and 8.9-lb rates of Counter, irrespective of whether the treatments were single applications of Counter or combinations that involved Counter plus a postemergence Lorsban spray.

Table 3. *Larval feeding injury* in an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	3.98 e
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	4.30 de
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	4.90 cd
Counter 20G	B	8.9 lb	1.8	5.33 bc
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	5.40 bc
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	5.50 bc
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	5.68 b
Poncho Beta	Seed		68 g a.i./ unit seed	5.70 b
Counter 20G	B	7.5 lb	1.5	5.73 b
Check	---	----	---	8.25 a
LSD (0.05)				0.742

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Seed = insecticidal seed treatment

Yield results for Study II at **St. Thomas** (Table 4) corresponded closely with the root maggot feeding injury rating data. The top-performing treatments, with regard to recoverable sucrose yield in Study II included the following: 1) Counter banded at 8.9 lb product/ac + Lorsban Advanced postemergence at 2 pts/ac; 2) Counter banded at 7.5 lb product/ac + Lorsban Advanced at 2 pts/ac; 3) Counter banded at 8.9 lb product/ac + Lorsban Advanced postemergence at 1 pt/ac; and 4) Poncho Beta-treated seed + Lorsban Advanced at 2 pts/ac. There were no significant differences among these treatments with respect to recoverable sucrose yield or root tonnage produced. The best treatment overall, regarding recoverable sucrose yield and gross economic return, was Counter banded at 8.9 lb product/ac + Lorsban Advanced postemergence at 2 pts/ac.

Table 4. ***Yield parameters*** **from an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, St. Thomas, ND, 2018**							
Treatment/ form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Sucrose yield (lb/ac)**	**Root yield (T/ac)**	**Sucrose (%)**	**Gross return ($/ac)**
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	9088 a	29.5 a	16.68 a	1123
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	8819 ab	29.8 a	16.23 a	1032
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	8390 abc	27.6 a	16.48 a	1019
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	8168 abc	28.0 a	16.00 a	935
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	8077 bc	28.3 a	15.80 a	889
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	7879 cd	27.8 a	15.80 a	859
Poncho Beta	Seed		68 g a.i./ unit seed	7077 de	23.4 b	16.58 a	852
Counter 20G	B	7.5 lb	1.5	6948 de	23.7 b	16.10 a	799
Counter 20G	B	8.9 lb	1.8	6434 e	21.8 b	16.10 a	747
Check	---	----	---	5251 f	18.9 c	15.18 a	552
LSD (0.05)				934.7	3.11	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Seed = insecticidal seed treatment

As observed in root injury rating data at St. Thomas, there was no significant difference in either recoverable sucrose yield or root tonnage between the 1- and 2-pts/ac rates of Lorsban Advanced in plots initially treated with the high (8.9 lb product/ac) rate of Counter 20G. When the lower (7.5-lb) rate of Counter was used at planting, the addition of the full rate (2 pts/ac) of Lorsban Advanced resulted in significantly greater levels of recoverable sucrose per acre than when the Lorsban was applied at 1 pt/ac. In plots initially treated with Poncho Beta, there was no significant difference in either recoverable sucrose yield or root tonnage between those that received Lorsban Advanced at 1 pt/ac and those that received Lorsban at the 2-pt/ac rate. The 1 pt/ac rate of Lorsban Advanced did not provide a significant increase in sucrose yield over plots that had only been protected by Poncho Beta seed treatment; however, that rate did results in significantly greater root tonnage when compared to the Poncho Beta-only plots. There were no significant differences in recoverable sucrose or root yields between any of the single-component (i.e., at-plant-only) insecticide programs in Study II, irrespective of whether the insecticide involved Counter 20G or Poncho Beta.

Although statistical significance testing is not performed on gross economic return, it bears noting that applying Lorsban Advanced at its high rate provided major economic benefits at the St. Thomas location. For example, when Lorsban Advanced was applied at 2 pts/ac to plots initially treated with Counter 20G, gross revenues were between $104 and $143/ac greater than those recorded in similar plots where the 1-pt/ac rate of Lorsban was used. Similarly, when Poncho Beta-treated seed was used for at-plant protection, gross revenue in plots that received the full labeled rate (2 pts/ac) of Lorsban Advanced generated $76/ac gross economic return than Poncho Beta plots treated with a postemergence application of Lorsban Advanced at the 1-pt/ac rate.

Results from sugarbeet root maggot feeding injury assessments in Study II at the **Thompson, ND** location appear in Table 5. The average feeding injury recorded in untreated check plots (5.7 on the 0 to 9 scale) suggests that a moderate root maggot infestation was present at the Thompson location. However, general trends in treatment performance were similar to those observed at St. Thomas. All insecticide programs, including single at-plant protection and dual-application (i.e., planting-time plus postemergence) treatments, resulted in significant reductions in sugarbeet root maggot feeding injury when compared to that observed in the untreated check plots. The lowest overall root maggot feeding injury in this trial occurred in plots protected by the treatment combination of Counter 20G at its high (8.9 lb/ac) rate plus a postemergence application of Lorsban Advanced at 2 pts product/ac. However, that treatment was not significantly superior to the following treatments: 1) Counter 20G at planting at 8.9 lb product/ac + postemergence Lorsban Advanced at 1 pt/ac; or Counter 20G at planting at 7.5 lb product/ac + a postemergence application of Lorsban Advanced at 2 pts/ac.

Under the more moderate SBRM pressure that occurred at the Thompson location, there was no significant advantage by using the higher (2 pts/ac) versus the lower (1-pt) rate of Lorsban Advanced in plots treated at planting with Counter 20G, irrespective of whether the Counter was applied at either 7.5 or 8.9 lb product/ac. Similarly, increasing the Lorsban Advanced rate from 1 to 2 pts product per acre in plots initially protected with Poncho Beta-treated seed did not provide a significant increase in root protection from SBRM feeding injury.

Table 5. *Larval feeding injury* in an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, Thompson, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	2.35 d
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	2.78 cd
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	3.20 bcd
Counter 20G	B	8.9 lb	1.8	3.28 bc
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	3.38 bc
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	3.43 bc
Poncho Beta	Seed		68 g a.i./ unit seed	3.80 b
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	3.80 b
Counter 20G	B	7.5 lb	1.5	3.85 b
Check	---	----	---	5.70 a
LSD (0.05)				0.891

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Seed = insecticidal seed treatment; Post Broad. = postemergence

Yield results from Study II at the **Thompson** location are provided in Table 6. Despite the differences observed in root maggot feeding injury ratings among treatments at this location, there were no statistically significant differences between any of the treatments in relation to recoverable sucrose, root tonnage, or percent sucrose, including comparisons between insecticide-protected treatments and the untreated check. This is partially due to the moderate SBRM infestation that developed at Thompson, but also likely a product of treatment plot variability among replicates.

Despite the lack of significant differences in yield parameters at Thompson, it is worth considering the relative gross economic returns provided by various insecticide regimes tested. For example, insecticide protection resulted in gross revenue increases ranging from $62 to $282/ac when compared to the untreated check. Although dual-insecticide (i.e., planting-time plus postemergence) programs tended to provide greater levels of recoverable sucrose yield and root tonnage, harvest quality (mainly percent sucrose content) appeared to negatively impact the gross economic return of some of the higher-yielding treatments. It appears that, under such low to moderate SBRM pressure, a grower could optimize gross economic return by either: 1) using Poncho Beta seed treatment as a stand-alone treatment and wait to determine if high SBRM fly numbers develop; or 2) minimizing the amount of postemergence Lorsban Advanced if Counter 20G is used (at either the 7.5 lb or 8.9 product/ac rate) as the planting-time component of a dual-insecticide program.

Table 6. *Yield parameters* from an evaluation of sugarbeet root maggot control by combining planting-time insecticide granules or seed treatments with postemergence liquid sprays, Thompson, ND, 2018 (2)							
Treatment/ form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Sucrose yield (lb/ac)**	**Root yield (T/ac)**	**Sucrose (%)**	**Gross return ($/ac)**
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 1 pt	1.8 0.5	10,886 a	36.2 a	16.55 a	1298
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	10,755 a	35.5 a	16.68 a	1346
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	10,584 a	35.7 a	16.40 a	1240
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 1 pt	68 g a.i./ unit seed 0.5	10,471 a	35.4 a	16.28 a	1157
Poncho Beta	Seed		68 g a.i./ unit seed	10,348 a	32.4 a	17.38 a	1377
Poncho Beta + Lorsban Advanced	Seed 3 d Pre-peak Broadcast	 2 pts	68 g a.i./ unit seed 1.0	10,154 a	33.2 a	16.73 a	1267
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	10,113 a	32.6 a	16.88 a	1164
Counter 20G	B	8.9 lb	1.8	9,905 a	31.7 a	17.00 a	1286
Counter 20G	B	7.5 lb	1.5	9,555 a	31.2 a	16.83 a	1169
Check	---	----	---	9,192 a	30.9 a	16.38 a	1095
LSD (0.05)				NS	NS	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Seed = insecticidal seed treatment; Post Broad. = postemergence

In general, the results from Study II indicate that effective root maggot control, especially under high SBRM infestation levels such as those that developed at St. Thomas for this trial, can result in significant yield and revenue increases. The results from our Thompson location also demonstrate that, under low to moderate SBRM pressure, even single-component insecticide programs can provide economic benefits that would still easily justify their use. In either scenario, these results show that effective pest management in relation to the associated risk of economic damage from sugarbeet root maggot feeding injury can contribute substantially to maximizing economic returns from sugarbeet production in areas affected by this pest.

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IMPACT OF INSECTICIDE SPRAY RATES, TIMING, AND PRODUCT ROTATIONS FOR POSTEMERGENCE ROOT MAGGOT CONTROL

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Introduction:

Severe infestations of the sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), frequently develop in central and northern portions of the Red River Valley (RRV) growing area of North Dakota and Minnesota. Sugarbeet root maggot populations in this production area have been mostly trending upward during much of the past decade. As such, this pest is an ongoing, and even growing threat to farm profitability for many producers growing sugarbeet within its range. This intense insect pressure typically requires aggressive pest management programs to ensure adequate protection of the sugarbeet crop. Pest management programs in areas at high risk for damaging SBRM infestations usually consist of either a granular insecticide or an insecticidal seed treatment at planting, followed by an additive postemergence insecticide application when the infestation level warrants it. The most commonly used approach for postemergence root maggot control in the RRV is a broadcast application of a sprayable liquid insecticide product.

Current U.S. Environmental Protection Agency labeling for all sprayable liquid insecticide products containing the active ingredient chlorpyrifos (e.g., Lorsban 4E, Lorsban Advanced, and all generic versions) includes a 10-day reapplication interval. This requires a 10-day period between successive applications of any sprayable liquid insecticide formulation that includes chlorpyrifos. The restriction, which began in 2010, lengthened the reapplication interval by three days. It has been thought that this restriction could impair growers' ability to effectively manage the SBRM with chlorpyrifos-based products, because high fly activity periods usually only persist for about seven days. In an effort to address this potential problem, research was undertaken to achieve the following objectives regarding postemergence SBRM management: 1) determine the most effective timing schemes for repeated applications of Lorsban Advanced sprays that adhere to its 10-day reapplication restriction; 2) assess the impact of application rate on Lorsban Advanced performance; and 3) evaluate Mustang Maxx as a single postemergence tool and as rotated with Lorsban Advanced applications for postemergence SBRM control.

Materials and Methods:

This experiment was conducted on a commercial sugarbeet field site near St. Thomas in southern Pembina County, ND. Betaseed 89RR52 glyphosate-resistant seed was used for all treatments. Plots were planted on 10 May, 2018. All plots were planted using a 6-row Monosem NG Plus 4 7x7 planter set to deliver seed at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. No insecticide was applied to the outer "guard" rows (i.e., rows one and six) of each plot, as those rows served as untreated buffers. Each plot was 35 feet long, and 35-foot tilled alleys were maintained between replicates throughout the growing season. The experiment was arranged in a randomized complete block design with four replications of the treatments.

<u>Planting-time insecticide applications</u>. Planting-time applications of Counter 20G were applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular application rates were regulated by using planter-mounted SmartBox™ computer-controlled insecticide delivery system that had been calibrated on the planter before all applications.

<u>Postemergence insecticide applications.</u> Additive postemergence insecticides used included Lorsban Advanced and Mustang Maxx. Treatments that included postemergence applications involved both single and double postemergence spray applications at varying rates. Treatment timings compared included seven and three days ahead of ("Pre-peak") SBRM fly activity (i.e., 31 May and 4 June, respectively, and one, four, and eight days after peak ("Post-peak") fly activity (i.e., 8, 12, and 15 June, resp.). Liquid insecticide solutions were delivered with a tractor-

mounted CO_2-propelled spray system equipped with TeeJet™ 110015VS nozzles calibrated to deliver applications in a finished output volume of 10 GPA.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in this experiment on 31 July by randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and scoring them in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. Plots were harvested on 24 September. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were extracted from soil using a mechanical harvester, and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

Data analysis: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

Sugarbeet root maggot feeding injury ratings in the untreated check plots averaged 7.93 on the 0 to 9 scale of Campbell et al. (2000) (Table 1), suggesting that a high SBRM infestation was present for the experiment. All insecticide treatments, including single-, dual-, and triple-insecticide application programs, resulted in significant reductions in SBRM feeding injury when compared to that sustained in the untreated check plots. Additionally, all treatments that included at least one postemergence insecticide spray resulted in significant increases in root protection when compared with similar plots that solely received the same amount of Counter at planting time.

Overall, the root injury rating results from this trial showed that applying the high rate (2 pts product/ac) of Lorsban Advanced was consistently superior to using the 1-pt rate of Lorsban under the high and sustained SBRM pressure that was present for this trial. Excellent SBRM control was achieved by applying Lorsban Advanced at the 2-pt rate at two widely separated (7 days pre-peak + 8 days post-peak; or 7 days pre-peak + 4 days post-peak) spray intervals, despite a moderate rate (7.5 lb product/ac) of Counter 20G being used at planting time. Results also demonstrated that, when the lower (1 pt/ac) rate of Lorsban Advanced was used for two postemergence applications, better control could be achieved by making the applications at the wider (7 days pre- and 8 days post-peak) interval than when made at a closer (7 days pre- and 4 days post-peak) spray interval.

Another positive finding was that Mustang Maxx provided comparable postemergence SBRM control to that of the 1-pt rate of Lorsban Advanced. Mustang also appeared to be an effective rotation partner product with Lorsban Advanced in plots that received applications of these insecticides spaced 4 days apart, and there was no significant impact on root protection by applying either Mustang or Lorsban first in the rotation. The following treatments provided the best protection from SBRM feeding injury in this trial:

1) planting-time Counter 20G at 7.5 lb/ac + two 2-pt/ac postemergence applications of Lorsban Advanced at 7 days pre-peak and 8 days post-peak;
2) planting-time Counter 20G at 7.5 lb/ac + two 2-pt/ac postemergence applications of Lorsban Advanced at 7 days pre-peak and 4 days post-peak; and
3) planting-time Counter 20G at 7.5 lb/ac + two 1-pt/ac postemergence applications of Lorsban Advanced at 7 days pre-peak and 8 days post-peak.

Good root protection from SBRM larval feeding injury was also achieved with the following treatments:

1) planting-time Counter 20G at 7.5 lb/ac + 1 pt/ac of Lorsban Advanced at 3 days pre-peak + 4 fl oz/ac of Mustang Maxx at 1 day post-peak;
2) planting-time Counter 20G at 7.5 lb/ac + 4 fl oz/ac of Mustang Maxx at 3 days pre-peak+ 1 pt/ac of Lorsban Advanced at 1 day post-peak;
3) planting-time Counter 20G at 8.9 lb/ac + a single 2-pt/ac postemergence application of Lorsban Advanced at 3 days pre-peak;
4) planting-time Counter 20G at 7.5 lb/ac + two 1-pt/ac postemergence applications of Lorsban Advanced at 3 days pre-peak and 8 days post-peak; and
5) planting-time Counter 20G at 7.5 lb/ac + 4 fl oz/ac of Mustang Maxx at 3 days pre-peak.

Table 1. ***Larval feeding injury*** **in an assessment of postemergence insecticide spray timing, rate, and frequency impacts on sugarbeet root maggot control, St. Thomas, ND, 2018**				
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Root injury (0-9)**
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	3.10 h
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	3.15 h
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	3.73 gh
Counter 20G + Lorsban Advanced + Mustang Maxx	B 3 d Pre-peak Broadcast 1 d Post-peak Broadcast	7.5 lb 1 pt 4 fl oz	1.5 0.5 0.025	3.88 fg
Counter 20G + Mustang Maxx + Lorsban Advanced	B 3 d Pre-peak Broadcast 1 d Post-peak Broadcast	7.5 lb 4 fl oz 1 pt	1.5 0.025 0.5	3.90 fg
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	4.13 efg
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 3 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	4.28 efg
Counter 20G + Mustang Maxx	B 3 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	4.35 d-g
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	4.53 c-f
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	4.60 cde
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	5.03 cd
Counter 20G	B	8.9 lb	1.8	5.08 c
Counter 20G	B	7.5 lb	1.5	6.13 b
Check	---	---	---	7.93 a
LSD (0.05)				0.689

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Post Broad = postemergence broadcast

Yield results and associated gross economic returns from this trial are presented in Table 2. All treatments that included at least one postemergence insecticide spray provided significant increases in both recoverable sucrose yield and root tonnage. Single planting-time applications of Counter 20G (i.e., both 7.5- and 8.9-lb rates) were the only treatments in the entire trial that did not provide significant increases in recoverable sucrose and sugarbeet root yield. As observed with root injury rating data, excellent sucrose and root yields resulted from treatment combinations that included at least one postemergence application of Lorsban Advanced at its high labeled rate (2 pts product/ac). The best overall treatments in this trial with regard to recoverable sucrose yield included the following:

1) planting-time Counter at 8.9 lb/ac + a single 2-pt/ac postemergence application of Lorsban Advanced at 3 days pre-peak;
2) planting-time Counter 20G at 7.5 lb/ac + two 2-pt/ac postemergence applications of Lorsban Advanced at 7 days pre-peak and 4 days post-peak;
3) planting-time Counter at 7.5 lb/ac + two 2-pt/ac postemergence applications of Lorsban Advanced at 7 days pre-peak and 8 days post-peak; and
4) planting-time Counter at 7.5 lb/ac + a single 1-pt/ac postemergence application of Lorsban Advanced at 3 days pre-peak;
5) planting-time Counter at 7.5 lb/ac + two 1-pt/ac postemergence applications of Lorsban Advanced at 7 days pre-peak and 4 days post-peak; and
6) planting-time Counter at 7.5 lb/ac + 4 fl oz/ac of Mustang Maxx applied postemergence at 3 days pre-peak + 1 pt/ac of Lorsban Advanced at 1 day post-peak.

There were no significant different differences among these top six treatments with regard to recoverable sucrose yield. The highest root tonnage yield was achieved by applying Counter 20G at 8.9 lb/ac, and following that with one postemergence application of Lorsban Advanced at 2 pts/ac. However, the best overall performing treatment, in considering protection from SBRM feeding injury, recoverable sucrose yield, root tonnage, and resulting gross revenue was the combination of planting-time Counter 20G at 7.5 lb/ac plus two 2-pt/ac applications of Lorsban Advanced, one at 7 days pre-peak and the second one at 4 days after peak SBRM fly activity. This combination generated $476/ac more gross revenue than the untreated check plots, and $29/ac more greater revenue than any other insecticide treatment combination tested in this experiment.

Table 2. *Yield parameters* from an assessment of postemergence insecticide spray timing, rate, and frequency impacts on sugarbeet root maggot control, St. Thomas, ND, 2018 (5)

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	8.9 lb 2 pts	1.8 1.0	8886 a	28.5 a	16.80 a	1118
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	8783 a	26.7 ab	17.55 a	1182
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 2 pts 2 pts	1.5 1.0 1.0	8529 a	25.8 bc	17.60 a	1153
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 2 pts	1.5 1.0	8192 ab	25.7 bc	17.10 a	1059
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 4 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	8166 ab	25.6 bc	17.03 a	1058
Counter 20G + Mustang Maxx + Lorsban Advanced	B 3 d Pre-peak Broadcast 1 d Post-peak Broadcast	7.5 lb 4 fl oz 1 pt	1.5 0.025 0.5	8114 abc	26.4 ab	16.55 a	998
Counter 20G + Lorsban Advanced + Mustang Maxx	B 3 d Pre-peak Broadcast 1 d Post-peak Broadcast	7.5 lb 1 pt 4 fl oz	1.5 0.5 0.025	7583 bcd	24.4 bcd	16.78 a	952
Counter 20G + Mustang Maxx	B 3 d Pre-peak Broadcast	7.5 lb 4 fl oz	1.5 0.025	7352 dc	23.5 cd	16.90 a	931
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	7248 d	23.8 cd	16.53 a	881
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 7 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 1.0 1.0	7234 d	23.5 cd	16.65 a	894
Counter 20G + Lorsban Advanced + Lorsban Advanced	B 3 d Pre-peak Broadcast 8 d Post-peak Broadcast	7.5 lb 1 pt 1 pt	1.5 0.5 0.5	7087 de	22.1 de	17.15 a	924
Counter 20G	B	8.9 lb	1.8	6386 ef	20.8 ef	16.60 a	785
Counter 20G	B	7.5 lb	1.5	6030 f	19.6 f	16.68 a	745
Check	---	---	---	5889 f	19.6 f	16.43 a	706
LSD (0.05)				801.6	2.35	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Post Broad. = postemergence broadcast

One major positive finding in this study was that spreading out two postemergence applications of Lorsban Advanced to between 11- and 15-day intervals (i.e., 7 days pre- + 4- or 8-days post-peak) did not appear to compromise control, as long as the high rate (2 pts/ac) of Lorsban was used for both applications. However, when Lorsban Advanced was applied at the lower (1 pt/ac) rate, the 11-day (7 days pre- and 4 days post-peak) reapplication interval was statistically superior to the wider (15-day; i.e., 7 days pre-peak and 8 days post-peak) re-spray interval. Applying the successive 1-pt applications of Lorsban Advanced at the 11-day interval increased recoverable sucrose by 932 lb/ac and root yield by 2.1 tons/ac, and also generated $164/ac more in gross economic return than when the same rate of Lorsban Advanced was applied at a 15-day re-spray interval. Another interesting finding was that, in treatments that involved two postemergence applications of the lower (1 pt/ac) rate of Lorsban Advanced at an 11-day respray interval, recoverable sucrose and root yield were significantly increased (by 1,079 lb and 3.5 tons/ac, respectively) when the Lorsban applications were made at 7 days pre-peak and 4 days post-peak, as opposed to applying them at 3 days pre-peak and 8 days after peak fly. This may have resulted from the sustained period of high fly activity surrounding the main peak in fly activity. As such, these comparisons should probably be tested further.

Postemergence applications of Mustang Maxx (4 oz product/ac) appeared to provide similar yield benefits to those of the lower (1 pt product/ac) rate of Lorsban Advanced, and adding Mustang Maxx in the postemergence spray rotation provided significant increases in both recoverable sucrose (866 lb/ac) and root yield (2.6 tons/ac) if the

Mustang was applied first in the rotation. This contradicts findings from those observed in 2017; however, it should also be noted that there was no significant difference in either sucrose yield or root tonnage in comparing the two treatments that involved either Mustang Maxx followed by Lorsban Advanced or the reverse-order rotation of these two products. Therefore, more research on this rotation scheme may also be needed.

Overall, most of the SBRM control programs evaluated in this experiment provided effective SBRM control that translated to major yield and revenue benefits. Another general conclusion that can be drawn is that the root protection, yield, and revenue benefits from additive postemergence insecticides demonstrate that they are cost-effective tools that easily pay for themselves in areas where moderately high to severe SBRM populations occur.

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APPLICATION RATE AND TIMING IMPACTS ON PERFORMANCE OF THIMET 20G FOR POSTEMERGENCE CONTROL OF THE SUGARBEET ROOT MAGGOT

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is a significant economic pest of sugarbeet in central and northern portions of the Red River Valley (RRV) growing area of Minnesota and North Dakota. Root maggot populations in this region have been at very high levels in recent years. Currently, only a small number of insecticide products labeled for use in sugarbeet have been shown to provide cost-effective SBRM control. Therefore, a major research goal has been to refine and optimize strategies for using postemergence insecticides to improve SBRM management for growers in areas affected by this pest. The key objective of this experiment was to assess the impacts of application timing and rate on the performance of Thimet 20G insecticide when applied as a postemergence rescue insecticide for SBRM control in the Red River Valley. A secondary objective was to compare moderate and high rates of Counter 20G (i.e., 7.5 and 8.9 lb product/acre, respectively) as planting-time components in dual-insecticide (i.e., planting-time + postemergence) programs for root maggot control.

Materials and Methods:

This study was carried out on two commercial field sites: one near St. Thomas in southern Pembina County, ND (Study I), and a second site near Thompson in Grand Forks County, ND. Plots were planted on 10 and 15 May, 2018 at St. Thomas and Thompson, respectively, using a 6-row Monosem NG Plus 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. The outer two rows of each plot served as buffers, and did not receive planting-time insecticide. Individual plots were 35 feet long, and 35-foot tilled alleys were maintained between replicates throughout the growing season. The experiment was arranged in a randomized complete block design with four replications of the treatments. Counter 20G was applied as a base planting-time insecticide for all plots that received insecticide protection, and it was applied at either the moderate (7.5 lb product/ac) or high (8.9 lb/ac) labeled rate. Band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders, was used for all Counter 20G applications. Granular output rates were regulated by using a planter-mounted SmartBox™ computer-controlled insecticide system that was calibrated on the planter before planting.

At the St. Thomas location, postemergence Thimet 20G granules were applied at either 13 or seven days before peak fly activity (i.e., 25 or 31 May, respectively), and rates of Thimet 20G included 4.9 and 7 lb product/ac. The same rates of Thimet were tested at Thompson, and they were applied on the same dates, which were 11 and 5 days before peak fly at Thompson. As with at-plant applications, granular output rates were regulated by using a SmartBox™ system mounted on a tractor-drawn four-row toolbar, and placement of insecticide in 4-inch bands was achieved by using Kinze™ row banders. Granules were incorporated by using two pairs of metal rotary tines that straddled each row. A set of tines was positioned ahead of each bander, and a second pair was mounted behind the granular drop zone. Lorsban Advanced, applied in a broadcast at 1 pt product/ac using TeeJet™ 110015VS nozzles, was also included in this experiment for comparative purposes. This application was made on 4 June at both locations, which was three days before the main peak in SBRM fly activity at St. Thomas, and one day pre-peak at Thompson.

<u>Root injury ratings</u>: Root maggot feeding injury assessments were carried out on 31 July (St. Thomas) and 2 August (Thompson) by randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and scoring them in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

<u>Harvest</u>: Performance was also compared using sugarbeet yield parameters derived by harvesting roots from all treatment plots. Plots at the St. Thomas location were harvested on 25 September, and the Thompson plots were harvested on 20 September. All foliage was removed from plots immediately before each respective harvest by using a commercial-grade mechanical defoliator. On the same day, all beets from the center two rows of each plot were extracted from soil by using a mechanical harvester, and weighed in the field using a digital scale. A representative

subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

Data analysis: All data from root injury ratings and yield/quality analyses were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012). Treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance.

Results and Discussion:

St. Thomas: Root maggot feeding injury results from the St. Thomas location of this trial are presented in Table 1. The SBRM infestation present for this experiment was considered severe, as was evidenced by the high average root maggot feeding injury rating of 7.95 (0 to 9 scale of Campbell et al. 2000) in the untreated check plots. All insecticide entries, including single planting-time applications, as well as treatments involving a planting-time insecticide plus either a postemergence application of Thimet 20G or Lorsban Advanced, provided significant reductions in SBRM feeding injury when compared to the untreated check plots.

Table 1. *Larval feeding injury* in an evaluation of Thimet 20G application timing and rate on sugarbeet root maggot control, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	4.95 e
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	5.33 de
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	5.43 de
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	5.80 cd
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	5.83 cd
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	6.08 c
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	6.70 b
Counter 20G	B	8.9 lb	1.8	6.73 b
Counter 20G	B	7.5 lb	1.5	7.03 b
Check	-----	----	-----	7.95 a
LSD (0.05)				0.538

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Post B = 4-inch postemergence band

General trends at St. Thomas indicated that later (7 days before peak fly activity) postemergence applications of Thimet 20G provided slightly better root protection than those applied earlier (13 days pre-peak). For example, the treatment combination of planting-time Counter 20G at its high (8.9 lb product/ac) rate, combined with a postemergence application of Thimet 20G at 7 lb product/ac at 7 days pre-peak, resulted in significantly lower SBRM feeding injury than the same treatment combination when the Thimet was applied earlier at 13 days pre-peak. Similarly, when both planting-time Counter and postemergence Thimet were applied at lower rates (7.5 and 4.9 lb product/ac, respectively), applying the Thimet at 7 days pre-peak performed significantly better at protecting roots from SBRM larval feeding injury than when it was applied 13 days before peak fly activity.

The postemergence application of Lorsban Advanced at 50% of its labeled maximum single application rate (1 pt product/ac) to plots that were initially treated at planting time with Counter 20 at 7.5 lb product/ac did not provide a significant improvement in root protection when compared to similar plots that had only received a planting-time Counter at the same (7.5-lb) rate. Although both of the single planting-time-only applications of Counter 20G provided significant reductions in root maggot feeding injury when compared to the untreated check plots, there was no statistical difference in performance between the 7.5- and 8.9-lb application rates. This was the case for treatments that involved both single, planting-time-only applications of Counter, as well as those involving planting-time Counter

20G and postemergence applications of Thimet. As such, this suggests that the higher rate of Counter 20G may not be necessary in dual-insecticide programs that include postemergence applications of Thimet 20G at its highest (7 lb product/ac) labeled rate, even under high SBRM pressure such as that which occurred at the St. Thomas location of this trial.

Yield data from St. Thomas are presented in Table 2. All insecticide-treated entries resulted in significant increases in recoverable sucrose yield, root tonnage, and percent sucrose when compared to the untreated check. There were no statistically significant differences between any of the dual (i.e., planting-time plus postemergence) insecticide entries in this trial. However, the only treatment combinations that resulted in significantly greater recoverable sucrose yield than the two single planting-time applications of Counter 20G included the following: 1) Counter 20G at its moderate (7.5 lb product/ac) rate plus a postemergence application of Thimet 20G at the high (7 lb/ac) rate at 7 days pre-peak; and 2) Counter 20G at 7.5 lb product/ac plus postemergence Thimet 20G at its low (4.9 lb/ac) labeled rate, which was also applied 7 days before peak fly activity. Similarly, the treatment combination of Counter 20G at 7.5 lb product per acre plus postemergence Thimet 20G at its high (7 lb/ac) rate at 7 days pre-peak was the only entry that significantly increased root yield over those of the single planting-time applications of Counter 20G. There were no significant differences in percent sucrose content between any of the insecticide-treated entries. As observed in previous years of testing these insecticide regimes, none of the yield parameters measured were impacted by Thimet 20G application rate or timing at St. Thomas in 2018.

Table 2. Impacts of Thimet 20G application timing and rate on *yield parameters* in an evaluation of sugarbeet root maggot control, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	8784 a	27.8 a	17.00 a	1124
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	8531 a	26.7 ab	17.13 a	1108
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	8233 ab	26.1 ab	16.93 a	1053
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	8187 ab	25.9 ab	17.03 a	1046
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	8078 ab	25.6 ab	16.98 a	1031
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	7939 ab	24.8 ab	17.18 a	1031
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	7803 ab	24.9 ab	17.03 a	986
Counter 20G	B	7.5 lb	1.5	7297 b	24.4 b	16.30 a	867
Counter 20G	B	8.9 lb	1.8	7269 b	23.8 b	16.58 a	887
Check	-----	----	-----	4201 c	15.1 c	15.28 b	442
LSD (0.05)				1042.0	3.00	0.974	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Post B = postemergence band

All insecticide treatments provided exceptional increases in gross revenue at the St. Thomas location of this trial. For example, even when insecticide protection was limited to a single planting-time application of Counter 20G, gross revenue was increased by between $425 and $445 when compared to the revenue recorded for the untreated check. The treatment combination of planting-time Counter 20G at 7.5 lb product per acre plus a postemergence broadcast application of Lorsban Advanced at 1 pt product per acre generated a gross revenue increase of $589 over the untreated check and an additional $164 in revenue compared to similar plots that received the planting-time-only application of Counter at 7.5 lb/ac. The highest overall gross revenue in this trial at St. Thomas was recorded for plots treated at planting with Counter 20G at 7.5 lb/ac and at 7 days pre-peak with Thimet 20G at its high (7 lb product/ac) rate. This combination generated $1,124/ac in gross revenue, which was an increase of $682/ac above that of the untreated check, and $257 above the single planting-time application of Counter at 7.5 lb/ac. Applying this treatment later (i.e., 7 days pre-peak) resulted in a revenue increase of $93/ac when compared to the revenue achieved from similar plots that received the Thimet earlier (i.e., 13 days before peak fly). Similarly, when lower rates of both Counter (7.5 lb/ac) and Thimet (4.9 lb/ac) were used, applying the postemergence Thimet at 7 days pre-peak increased gross revenue by $122/ac when compared to applying the Thimet in the same Counter/Thimet rate regime, but at 13 days before peak fly.

Thompson: Root injury rating results from the Thompson, ND location of this trial are provided in Table 3. Sugarbeet root maggot feeding pressure at this location was considered moderate, as indicated by the average SBRM feeding injury rating of 5.6 on the 0 to 9 scale of Campbell et al. (2000) that was recorded for roots from the untreated check plots. However, general trends in both root rating and yield data corresponded closely with those observed at the St. Thomas location.

At Thompson, all of the insecticide entries in this trial provided significant reductions in SBRM feeding injury when compared to the untreated check. Plots that received postemergence Thimet applications that were made closer to (i.e., 5 days before) peak activity had numerically lower levels of SBRM feeding injury than those treated earlier (11 days pre-peak) with postemergence Thimet; however, there were no significant differences in root protection as related to Thimet application timing, irrespective of the rate of planting-time Counter or postemergence Thimet being used. The postemergence application of Lorsban Advanced at its moderate (1 pt product/ac) rate to plots initially treated with Counter 20G at 7.5 lb/ac was the only postemergence insecticide application that did not provide a significant improvement in root protection when compared to similar plots that had only received the single planting-time application of Counter 20G at the same rate. Also, in comparing postemergence SBRM tools overall, plots that received Thimet had significantly less SBRM feeding injury than those treated at postemergence with Lorsban Advanced, irrespective of Thimet application timing or rate.

Table 3. *Larval feeding injury* in an evaluation of Thimet 20G application timing and rate on sugarbeet root maggot control, Thompson, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	1.95 c
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	1.98 c
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	2.35 c
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	2.45 c
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	2.53 c
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	2.58 c
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	3.43 b
Counter 20G	B	8.9 lb	1.8	3.65 b
Counter 20G	B	7.5 lb	1.5	3.78 b
Check	-----	----	-----	5.60 a
LSD (0.05)				0.718

Means within a column sharing a letter are not significantly (*P* = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Post B = 4-inch postemergence band

Yield data from the Thompson location appear in Table 4. Trends in yield results corresponded closely with root injury rating data, and also supported our findings for both root rating and yield data from St. Thomas. For example, later applications of postemergence Thimet 20G at Thompson tended to provide slightly greater sucrose yields and root tonnage than earlier applications in plots that received the same amount of planting-time Counter. All dual-insecticide combinations that involved a later (i.e., 5 days before peak fly vs. 11 days pre-peak) postemergence application of Thimet 20G resulted in significant increases in recoverable sucrose yield when compared to the untreated check plots. The only dual-insecticide combination involving an earlier (i.e., 11 days pre-peak) postemergence application of Thimet that provided a significant increase in recoverable sucrose yield when compared to the untreated check was when both planting-time Counter and postemergence Thimet were applied at high rates (i.e., 8.9 and 7 lb product/ac, respectively).

Table 4. Impacts of Thimet 20G application timing and rate on *yield parameters* in an evaluation of sugarbeet root maggot control, Thompson, ND, 2018							
Treatment/form.	**Placement[a]**	**Rate (product/ac)**	**Rate (lb a.i./ac)**	**Sucrose yield (lb/ac)**	**Root yield (T/ac)**	**Sucrose (%)**	**Gross return ($/ac)**
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	12,136 a	38.9 a	16.95 a	1528
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	11,054 b	36.6 ab	16.65 a	1331
Counter 20G + Thimet 20G	B 7 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	10,880 b	34.7 b-e	17.20 a	1379
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 7 lb	1.5 1.4	10,726 b	35.7 bcd	16.55 a	1281
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	8.9 lb 7 lb	1.8 1.4	10,518 bc	36.3 abc	16.03 a	1189
Counter 20G + Thimet 20G	B 13 d Pre-peak Post B	7.5 lb 4.9 lb	1.5 1.0	10,458 bc	35.3 bcd	16.28 a	1224
Counter 20G + Lorsban Advanced	B 3 d Pre-peak Broadcast	7.5 lb 1 pt	1.5 0.5	10,322 bc	33.4 cde	16.90 a	1283
Counter 20G	B	8.9 lb	1.8	10,206 bc	34.4 b-e	16.50 a	1199
Counter 20G	B	7.5 lb	1.5	10,099 bc	33.1 de	16.70 a	1232
Check	-----	----	-----	9,571 c	32.1 e	16.38 a	1130
LSD (0.05)				999.8	3.17	NS	

Means within a column sharing a letter are not significantly (*P* = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; Post B = 4-inch postemergence band

The highest recoverable sucrose yield in this trial at Thompson was achieved with the dual-insecticide combination comprised of planting-time Counter 20G at 7.5 lb/ac plus 4.9 lb/ac of Thimet 20G postemergence at 5 days before peak SBRM fly activity. This combination was the only dual-insecticide combination that resulted in significantly greater recoverable sucrose yield than either of the planting-time-only Counter treatments. It also generated more root yield than all treatments, except the following: 1) planting-time Counter at 7.5 lb/ac plus a postemergence application of Thimet at 7 lb/ac at 5 days pre-peak; and 2) planting-time Counter at the high (8.9 lb/ac) rate plus postemergence Thimet applied at 7 lb/ac at 11 days pre-peak. There were no significant differences in percent sucrose content between any of the treatments in this study at Thompson, including comparisons between the best-performing insecticide combinations and the untreated check.

Despite relatively few significant differences among treatments in relation to yield in this study at the Thompson location, most insecticide programs in the experiment provided substantial revenue benefits when compared to the untreated check. The highest gross revenue of $1,528/ac was recorded for the treatment that included Counter 20G at planting time using its moderate rate (7.5 lb/ac) plus a postemergence application of Thimet 20G at its lower (4.9 lb/ac) rate at 5 days before peak fly activity. This combination generated $304 more revenue than when the same rates of Counter and Thimet were used, but the Thimet was applied earlier (i.e., 11 days pre-peak). In general, revenue increases from applying Thimet later (i.e., 5 days vs. 11 days pre-peak) in this trial ranged from $50 to the aforementioned $304/ac. Thus, even under the moderate SBRM pressure that existed at the Thompson location, dual-insecticide pest management programs clearly paid for themselves in additional gross revenue.

The single planting-time insecticide treatments at Thompson also provided cost-effective control and strong revenue increases above the untreated check that ranged from $69 to 102/ac for the 8.9- and 7.5-lb/ac rates of Counter 20G, respectively. The trend of slightly less revenue with the higher planting-time rate of Counter was observed with both planting-time-only as well as dual-insecticide programs involving later-applied postemergence Thimet at this location. This could suggest that using a moderate rate of Counter 20G at planting and combining it with a postemergence application of Thimet at either 4.9 or 7 lb/ac about one week before peak SBRM fly activity could optimize performance. More research may be needed to better understand this approach to sugarbeet root maggot control.

As observed in previous years of testing, the results of this experiment showed that combining at-plant Counter 20G with postemergence applications of Thimet 20G provides effective control of the sugarbeet root maggot. Although general trends suggested slightly better control and yield/revenue benefits when Thimet 20G was applied later (i.e., 5 to 7 days before peak fly activity), statistically significant differences related to Thimet application timing and rate were rare among the two study locations. This supports previous testing on similar dual-insecticide treatment regimes, and suggests that growers have a relatively wide (i.e., 1- to 2-week) window of flexibility in relation to when the Thimet must be applied to achieve effective SBRM control. The additional economic returns from postemergence insecticide applications in this experiment provide ample justification for the use of these materials to provide additive control of the sugarbeet root maggot, even under moderate sugarbeet root maggot pressure such as that which occurred at the Thompson location. As such, effective SBRM management programs, such as those comprised of the dual-insecticide tactics tested in this experiment, will be essential to ensuring the profitability of sugarbeet production in areas affected by moderate to high infestations of this pest.

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TWO SCREENING TRIALS ON EXPERIMENTAL INSECTICIDES IN THE ONGOING SEARCH FOR SUGARBEET ROOT MAGGOT CONTROL ALTERNATIVES

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder) is an annual economic threat to sugarbeet production on up to 85,000 acres of the Red River Valley (RRV) growing area. Unfortunately, only a limited number of insecticide products are currently registered by the U.S. Environmental Protection Agency (EPA) for insect management in sugarbeet. As a result, RRV sugarbeet producers have had to rely heavily on the same insecticide mode of action (i.e., acetylcholinesterase [ACHE] inhibition) to manage this pest for over four decades.

The frequently severe root maggot infestations that occur in the central and northern RRV often necessitate two to three applications of these materials each growing season to protect the crop from substantial economic loss. This long-term use of multiple applications of ACHE-inhibiting insecticides has exerted intense selection pressure for the development of insecticide resistance in root maggot populations in the RRV. Therefore, research is critically needed to develop alternative materials and strategies for root maggot management to ensure the long-term sustainability and profitability of sugarbeet production for growers affected by this pest. This research involved two experiments that were carried out to achieve the following objectives: 1) test several natural and/or botanical insecticides for efficacy at managing the sugarbeet root maggot; and 2) evaluate commercially available, EPA-registered conventional chemical insecticides that are currently not registered for use in sugarbeet to determine if their performance would warrant future pursuit of labeling for sugarbeet root maggot control.

Materials and Methods:

This research involved two experiments (Study I and Study II) that were carried out on a commercial sugarbeet field site near St. Thomas (Pembina County), ND. Both experiments were planted on 14 May, 2018 with Betaseed 89RR52 glyphosate-resistant seed by using a 6-row Monosem NG Plus 4 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. Insecticide was excluded from the outer "guard" rows (i.e., rows one and six) on each side of each plot, and those rows served as untreated buffers. Individual treatment plots were 35 feet long, and 35-foot-wide alleys between replicates were maintained weed-free via cultivation throughout the growing season. Both studies were arranged in a randomized complete block design with four replications of the treatments. Counter 20G (granular) insecticide was used for comparative purposes as a planting-time SBRM management standard in both experiments. The Counter 20G was applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular application rates were regulated by using a planter-mounted SmartBox™ computer-controlled insecticide delivery system calibrated on the planter immediately before all applications. Study-specific materials and methods for the two respective experiments are described below, and they are followed by descriptions of materials and methods used for root injury assessments, plot harvest, and data analyses that were common to both studies:

<u>Study I</u>: Planting-time liquid insecticides in Study I included the following: 1) Aza-Direct (active ingredient: azadirachtin, a neem tree-derived insect antifeedant and growth disruptor); 2) Knack 0.86EC (an insect growth regulator insecticide); Endigo (a combination insecticide containing lambda-cyhalothrin [a pyrethroid insecticide] and thiamethoxam [a neonicotinoid] as active ingredients), and Larva Biocontrol (a liquid solution containing insect-pathogenic nematodes [*Steinernema carpocapsae*]). Planting-time liquid products in Study I were delivered in 3-inch T-bands over the open seed furrow by using a planter-mounted, CO_2-propelled spray system calibrated to deliver a finished spray volume output of 5 GPA through TeeJet™ 400067E nozzles. Water used for all planting-time liquid insecticide applications in Study I was adjusted to pH 6.0 about one week before planting.

Postemergence insecticide treatments in Study I included the following sprayable liquids: Captiva (an insect repellent comprised of capsicum [pepper] extract, garlic oil, and soybean oil]), Dibrom Emulsive (active ingredient: naled, a conventional organophosphate insecticide), Ecozin Plus 1.2%ME (azadirachtin), Evergreen Crop Protection 60-6EC (pyrethrum + a synergist), Spidermite Control (active ingredient: containing geraniol, a monoterpenoid and an alcohol, as its active ingredient), Spore Control (active ingredient: Thymol, a phenolic antimicrobial compound), Veratran D (a botanical material containing insecticidal alkaloids from the Sabadilla plant), Vydate C-LV (active ingredient: oxamyl, a conventional carbamate insecticide), Warrior II (active ingredient: lambda-cyhalothrin, a pyrethroid insecticide formulated with Zeon® U.V. protection), and all were compared with Lorsban Advanced (active ingredient: chlorpyrifos, an organophosphate) as a postemergence chemical insecticide standard. All postemergence sprays were broadcast-applied on 6 June (i.e., about 1 day before peak SBRM fly activity) by using a tractor-mounted, CO_2-propelled spray system equipped with an 11-ft boom that was calibrated to deliver a finished spray volume output of 10 GPA through TeeJet™ 110015VS nozzles. Water used for all postemergence liquid insecticide applications in Study I was adjusted to pH 6.0.

Study II: All insecticide treatments in Study II were planting-time applications. Counter 20G was included as a planting-time granular standard, and it was applied at it's a moderate rate of 7.5 lb product per acre as described above. Planting-time liquid insecticides in Study II included Bifender FC (bifenthrin, a pyrethroid insecticide), and Midac FC (imidacloprid, a neonicotinoid). All treatments involving Bifender and Midac were applied in a 20-GPA spray volume of 100% 10-34-0 (N-P-K) starter fertilizer solution through Teejet™ 650067 flat fan nozzles. Nozzle height was adjusted to achieve delivery of sprays in 3-inch bands over the open seed furrow. Dribble in-furrow applications were made directly into the open seed furrow through microtubes (1/4" outside diam.), and inline Teejet™ No.29 orifice plates were used to stabilize the spray volume output rate. To establish consistent fertility for all treatments, the same rate of starter fertilizer was also applied to Counter-treated plots and the untreated checks.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in this trial on 31 July by randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and scoring them in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

Harvest: Treatment performance was also compared on the basis of sugarbeet yield parameters. Plots were harvested on 25 September. Foliage was removed from plots immediately before harvest by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were extracted from the soil using a mechanical harvester, and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

Data analysis: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance

Results and Discussion:

It is important to note that most of the insecticide entries in both of these trials were single-component (i.e., either at-plant-only or postemergence-only) control tools, which are not recommended in areas such as St. Thomas, where severe SBRM infestations are common. Another important aspect of these trials was that sugarbeet root maggot fly activity began exceptionally early in 2018. A count of 72 flies per sticky stake (well above the season-long cumulative economic threshold) was recorded on 25 May, and high activity continued for over three weeks thereafter. Thus, relatively high SBRM infestations were present for both of these experiments.

Study I: Sugarbeet root maggot feeding injury in the untreated check plots of Study I averaged 7.08 on the 0 to 9 scale of Campbell et al. (2000), which indicated the presence of a high SBRM infestation (Table 1). Entries that provided the greatest levels of root protection (i.e., lowest SBRM feeding injury ratings) included postemergence-applied Vydate C-LV (34 fl oz/ac) and the planting-time standard, Counter 20G, applied at its moderate rate of 7.5 lb product/ac. There was no significant difference in root protection between Vydate and Counter. Other entries that were not statistically outperformed by Counter in root protection included the following: 1) Endigo ZC applied at planting in a 3-inch T-band at 4.5 fl oz/ac; 2) Lorsban Advanced, applied as a postemergence broadcast at 1 pt product/ac; 3) Evergreen Crop Protection at 16 fl oz/ac as a postemergence broadcast; and 4) Dibrom, applied postemergence as a broadcast at 1 pt product/ac. The only treatments that significantly reduced SBRM feeding injury when compared to the untreated check were Vydate, Counter, Endigo, Lorsban Advanced, and Evergreen crop protection.

Table 1. *Larval feeding injury* in an evaluation of experimental at-plant and postemergence sprays for sugarbeet root maggot control, St. Thomas, ND, 2018				
Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Vydate C-LV	1 d Pre-peak Broad.	34 fl oz	1.0	5.48 f
Counter 20G	B	7.5 lb	1.5	6.03 ef
Endigo ZC	3" TB	4.5 fl oz		6.25 de
Lorsban Advanced	1 d Pre-peak Broad.	1 pt	0.5	6.40 cde
Evergreen Crop Protection	1 d Pre-peak Broad.	16 fl oz		6.53 b-e
Dibrom	1 d Pre-peak Broad.	1 pt		6.68 a-e
Knack 0.86 EC	3" TB	10 fl oz		6.73 a-d
Captiva	1 d Pre-peak Broad.	2 pts		6.83 a-d
Larva Biocontrol + Spore Control + Spidermite Control	3" TB 1 d Pre-peak Broad.	5 fl oz 26 fl oz + 20 fl oz		6.90 a-d
Ecozin Plus 1.2% ME	1 d Pre-peak Broad.	56 fl oz		6.90 a-d
Veratran D	1 d Pre-peak Broad.	20 lb	0.04	6.90 a-d
Aza-Direct (0.0987 lb/gal)	3" TB	56 fl oz		6.90 a-d
Larva Biocontrol	3" TB	5 fl oz		7.03 abc
Check	---	---	---	7.08 ab
Warrior ll	1 d Pre-peak Broad.	1.92 fl oz	0.03	7.10 ab
Spore Control + Spidermite Control	1 d Pre-peak Broad.	26 fl oz/20 fl oz		7.20 a
LSD (0.05)				0.651

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; 3" TB = 3-inch T-band

Yield data from Study I are shown in Table 2. The highest-yielding treatments, in relation to both recoverable sucrose yield and root tonnage, included the following: 1) Counter 20G, applied at a moderate rate of 7.5 lb product/ac; 2) Vydate C-LV, applied as a postemergence broadcast at 34 fl oz/ac; 3) Endigo ZC, applied at planting in 3-inch T-bands at 4.5 fl oz/ac; Lorsban Advanced, applied in a postemergence broadcast at 1 pt/ac; and 4) Ecozin Plus, which was applied as a postemergence broadcast at 56 fl oz/ac. However, the only treatments that produced significant increases in recoverable sucrose and root yields compared to the untreated check were Counter 20G and Vydate C-LV, both of which are conventional chemical insecticides.

Table 2. *Yield parameters* from an evaluation of experimental at-plant and postemergence sprays for sugarbeet root maggot control, St. Thomas, ND, 2018							
Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Counter 20G	B	7.5 lb	1.5	7353 a	22.3 a	17.55 a	990
Vydate C-LV	1 d Pre-peak Broad.	34 fl oz	1.0	7304 a	22.2 a	17.50 a	984
Endigo ZC	3" TB	4.5 fl oz		6954 ab	21.2 ab	17.55 a	933
Lorsban Advanced	1 d Pre-peak Broad.	1 pt	0.5	6672 abc	20.6 abc	17.40 a	882
Ecozin Plus 1.2% ME	1 d Pre-peak Broad.	56 fl oz		6554 a-d	21.3 ab	16.53 a	808
Evergreen Crop Protection	1 d Pre-peak Broad.	16 fl oz		6392 bcd	19.6 b-e	17.25 a	852
Dibrom	1 d Pre-peak Broad.	1 pt		6364 bcd	20.1 a-d	16.98 a	815
Check	---	---		6260 b-e	19.6 b-e	17.18 a	814
Larva Biocontrol	3" TB	5 fl oz		6205 b-e	19.4 b-e	17.15 a	809
Captiva	1 d Pre-peak Broad.	2 pts		6147 b-e	19.8 b-e	16.83 a	766
Aza-Direct (0.0987 lb/gal)	3" TB	56 fl oz		6000 cde	19.4 b-e	16.78 a	746
Larva Biocontrol + Spore Control + Spidermite Control	3" TB 1 d Pre-peak Broad.	5 fl oz 26 + 20 fl oz		5962 cde	18.7 cde	17.10 a	771
Spore Control + Spidermite Control	1 d Pre-peak Broad.	26 + 20 fl oz		5797 de	18.6 cde	16.80 a	729
Veratran D	1 d Pre-peak Broad.	20 lb	0.04	5764 de	18.1 de	16.90 a	743
Warrior ll	1 d Pre-peak Broad.	1.92 fl oz	0.03	5735 de	18.4 cde	16.70 a	718
Knack 0.86 EC	3" TB	10 fl oz		5475 e	17.6 e	16.75 a	685
LSD (0.05)				846.0	2.25	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; 3" TB = 3-inch T-band; Broad. = Broadcast

Although few statistically significant improvements in yield parameters were observed in Study I, notable increases in gross revenue when compared to the untreated check were recorded for the following treatments (presented in descending order of gross revenue increase above the check): 1) Counter 20G ($176/ac); Vydate C-LV ($170/ac); Endigo ZC ($119/ac); Lorsban Advanced ($68/ac); and Evergreen Crop Protection ($38/ac).

It bears repeating that all insecticide-treated entries in Study I were single-application treatments, which is never recommended for SBRM management under the high to severe root maggot pressure that typically develops in the northern RRV. The overall goal of this experiment was simply to determine if any of the experimental insecticides tested have potential to provide a measurable level of root protection and associated yield benefits in relation to managing the sugarbeet root maggot. Once candidate insecticide materials with such potential are identified, future research will focus on integrating them into control programs that may include both planting-time insecticide protection (i.e., a granular, sprayable liquid, or seed treatment insecticide) and postemergence additive protection to optimize SBRM management methodology.

Study II:

Sugarbeet root maggot larval feeding injury rating data for Study II are presented in Table 3. Root maggot feeding injury in the fertilizer-only check (subsequently referred to as "check" or "untreated check") plots of this trial averaged 6.98 on the 0 to 9 scale of Campbell et al. (2000), which suggested the presence of a relatively high SBRM infestation for the experiment. All insecticide-based treatments in the experiment resulted in significant reductions in root maggot feeding injury when compared to the check. The lowest average SBRM feeding injury in Study II was observed in plots treated with Bifender FC at its higher (14.5 fl oz/ac) rate by using 3-inch T-band placement. Other entries in Study II that were not outperformed by this treatment included the following: 1) Counter 20G, applied as a 5-inch planting-time band at its moderate (7.5 lb product/ac) rate; 2) Midac FC, applied dribble in-furrow (DIF) at its high (13.5 fl oz/ac) rate; and 3) Midac FC, applied DIF at its low (6.9 fl oz/ac) rate.

Using a 3-inch T-band for placement of Bifender resulted in significantly greater root protection than when the product was applied at the same rate by using dribble in-furrow placement. Plots treated with the high rate T-banded application of Bifender at its high rate also had significantly less SBRM feeding injury than when it was applied either singly at its lower, 10.9 fl oz/ac rate, or when it was applied at the 10.9-oz rate and combined with Midac at 6.9 fl oz/ac as a tank mixture.

Although plots treated at planting time with Midac at its full (13.5 fl oz/ac) rate had numerically lower levels of SBRM feeding injury than those in which the lower (6.9 fl oz/ac) rate of Midac was used, there was no statistically significant difference in root protection between application rates of this product.

Table 3. *Larval feeding injury* in an evaluation of experimental at-plant sprays for sugarbeet root maggot control, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Bifender FC + 10-34-0	 3" TB	14.5 fl oz 5 GPA	0.19	4.80 e
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5	5.03 de
Midac FC + 10-34-0	 DIF	13.5 fl oz 5 GPA`	4.28	5.20 cde
Midac FC + 10-34-0	 DIF	6.9 fl oz 5 GPA	2.14	5.33 b-e
Bifender FC + 10-34-0	 DIF	10.9 fl oz 5 GPA	0.14	5.55 bcd
Bifender FC + Midac FC + 10-34-0	 DIF	10.9 fl oz 6.9 fl oz 5 GPA	0.14 2.14	5.75 bc
Bifender FC + 10-34-0	 DIF	14.5 fl oz 5 GPA	0.19	5.88 b
Fertilizer check	DIF	5 GPA		6.98 a
LSD (0.05)				0.644

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; DIF = Dribble in-furrow; 3" TB = 3-inch T-band

Yield results from Study II appear in Table 4. Performance patterns with regard to sugarbeet root maggot management tool impacts on yield parameters in this trial corresponded closely with those observed in root injury rating results. Plots treated with the 3-inch T-banded application of Bifender FC at its high (14.5 fl oz/ac) rate produced the highest recoverable sucrose and root yields in the experiment, and generated $290/ac greater gross revenue than when the same rate of Bifender was applied by using dribble-in-furrow placement. Plots protected by this entry produced significantly more root yield than any other treatment in this study, except Midac at its high (13.5 fl oz/ac) rate. The T-banded application of Bifender at its high rate also resulted in significantly more recoverable sucrose yield than all other treatments, except the tank mixture of Bifender (10.9 fl oz/ac) plus Midac FC at 6.9 oz/ac, and the 13.5-oz rate of Midac alone. The following treatments generated the highest rates of gross economic return when compared to the fertilizer check: 1) the tank mixture of Bifender FC at 10.9 fl oz/ac + Midac FC applied DIF at 6.9 oz/ac ($267/ac above the check); 2) Bifender FC applied in a 3-inch T-band at 14.5 fl oz/ac ($261/ac above the check); 3) Midac FC at its high rate of 13.5 fl oz/ac ($233/ac above the check); and 4) Counter 20G applied at its moderate rate of 7.5 lb product/ac ($182/ac more than the check).

Table 4. *Yield parameters* in an evaluation of experimental at-plant sprays for sugarbeet root maggot control, St. Thomas, ND, 2018

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Bifender FC + 10-34-0	3" TB	14.5 fl oz 5 GPA	0.19	8304 a	26.4 a	16.85 a	1057
Bifender FC + Midac FC + 10-34-0	DIF	10.9 fl oz 6.9 fl oz 5 GPA	0.14 2.14	7818 ab	23.5 b	17.73 a	1063
Midac FC + 10-34-0	DIF	13.5 fl oz 5 GPA`	4.28	7806 ab	24.1 ab	17.28 a	1029
Counter 20G + 10-34-0	B DIF	7.5 lb 5 GPA	1.5	7180 b	21.6 bcd	17.75 a	978
Bifender FC + 10-34-0	DIF	10.9 fl oz 5 GPA	0.14	7103 b	22.0 bc	17.20 a	933
Midac FC + 10-34-0	DIF	6.9 fl oz 5 GPA	2.14	7062 b	22.1 b	17.13 a	914
Fertilizer check	DIF	5 GPA		6199 c	19.6 cd	17.05 a	796
Bifender FC + 10-34-0	DIF	14.5 fl oz 5 GPA	0.19	6035 c	19.2 d	16.90 a	767
LSD (0.05)				813.0	2.66	NS	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; DIF = Dribble in-furrow; 3" TB = 3-inch T-band

Future research on Bifender and Midac should focus more on applying these materials via T-band placement. Additional (i.e., higher) rates of these products should also be investigated, especially when both materials are incorporated into a single tank mixture. It is encouraging that several of the treatments involving either Bifender FC or Midac FC provided similar levels of root maggot control, in relation to both root protection from SBRM feeding injury and resulting yield, to that of the moderate rate of Counter 20G. At a minimum, this suggests that these new insecticides may have merit as SBRM management tools, either as stand-alone tools under moderate root maggot pressure, or as components of dual-insecticide programs for managing high SBRM infestations.

Although some of the experimental treatments tested in these experiments achieved comparable performance levels to those observed with either Counter 20G or Lorsban Advanced (the two conventional standards used in these studies), both of the conventional insecticides were applied at moderate rates, and not the maximum rates allowed on their respective labels. As such, further testing should be carried out on these and other experimental materials to identify potential alternatives to the currently used products. Alternative insecticide options could help prevent or delay the development of insecticide resistance in SBRM populations to currently used chemistries, and could also provide viable tools for growers to sustainably and profitably manage this pest if currently available conventional insecticides become unavailable due to regulatory action.

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THREE-YEAR PERFORMANCE SUMMARY ON MOVENTO HL® INSECTICIDE FOR POSTEMERGENCE SUGARBEET ROOT MAGGOT CONTROL

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Introduction:

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis* (Röder), is the most economically significant insect pest of sugarbeet in the Red River Valley (RRV) growing area. In areas at moderate to high risk of damaging SBRM infestations, RRV sugarbeet producers typically manage this pest by prophylactically protecting their crop at planting time with either a granular insecticide or an insecticidal seed treatment during planting operations. In areas where severe SBRM infestations frequently develop, planting-time control efforts are often augmented by one to two postemergence insecticide applications. As far back as the mid-1970s, most of these applications have involved the use of insecticides in the organophosphate and carbamate classes to manage the sugarbeet root maggot. Both of these insecticide classes kill insects through the same mode of action, acetylcholinesterase (ACHE) inhibition.

Grower dependence on a single mode of action for SBRM control in the Red River Valley has been largely due to two factors. First, a limited number of insecticide products have been registered for use in the crop for much of this time. Second, despite frequent screening efforts on a variety of insecticides belonging to alternative modes of action, very few insecticidal products tested in screening programs have shown promise as viable options for SBRM control. As a result of this long-term, repeated use of ACHE inhibitor insecticides, the threat of insecticide resistance development in RRV sugarbeet root maggot populations has been a looming concern for pest management advisors and producers for several years.

In 2017, the U.S. Environmental Protection Agency approved the registration of Movento HL insecticide for use in sugarbeet. The addition of this product is encouraging from an insect resistance management perspective, because the active ingredient in Movento (i.e., spirotetramat) belongs to the lipid biosynthesis inhibitor (LBI) insecticide class, which is an alternative mode of action to the commonly used ACHE inhibitors. Thus far, after significant screening efforts have been conducted on insect species with known resistance to other insecticides, there is no evidence of cross resistance between the LBI insecticides and other classes. This project was carried out to evaluate the efficacy of Movento HL as a postemergence tool for sugarbeet root maggot control. A secondary objective was to assess the performance of dual-insecticide programs for SBRM management that include Poncho Beta as the planting-time insecticide component and Movento HL as the postemergence rescue component.

Materials and Methods:

This three-year experiment was conducted on grower-owned field sites near St. Thomas in rural Pembina County, ND during the 2016-2018 growing seasons. Betaseed 89RR52 glyphosate-resistant seed was used for all treatments each year. Plots were planted on 11 May in 2016 and 2018, and on 10 May in 2017. All plots were planted using a 6-row Monosem NG Plus 4 7x7 planter set to deliver seed at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Plots were six rows (22-inch spacing) wide with the four centermost rows treated. Insecticide was excluded from each of the outside rows (i.e., rows 1 and 6) of the planter, and those "guard rows" served as untreated buffers. Each plot was 35 feet long, and 35-foot alleys between replicates were maintained weed-free by using periodic cultivation throughout the growing season. The experiment was arranged in a randomized complete block design with four replications in 2016 and 2018, and three replications in 2017.

Planting-time insecticide applications: Planting-time applications of Counter 20G were applied by using band (B) placement (Boetel et al. 2006), which consisted of 5-inch swaths of granules delivered through Gandy™ row banders. Granular application rates were regulated by using planter-mounted SmartBox™ computer-controlled insecticide delivery system that had been calibrated on the planter before all applications.

Postemergence insecticide applications: Additive postemergence insecticides in this trial included Movento HL, Lorsban Advanced, and Mustang Maxx. Insecticide application timings evaluated included the following: 1) Lorsban Advanced and Mustang Maxx, applied between two and three days before peak SBRM fly activity; 2) Movento HL at 6-7 days pre-peak; and 3) Movento HL applied either one day before or on the peak fly activity date. Postemergence liquid insecticide solutions were delivered by using a tractor-mounted CO_2-propelled spray system equipped with TeeJet™ 110015VS nozzles and calibrated to deliver applications in a finished output volume of 10 GPA. All Movento sprays included methylated seed oil at the recommended rate of 0.25% v/v.

Root injury ratings: Sugarbeet root maggot feeding injury was assessed in this experiment between 30 July and 3 August each year. Sampling consisted of randomly collecting ten beet roots per plot (five from each of the outer two treated rows), hand-washing them, and scoring them in accordance with the 0 to 9 root injury rating scale (0 = no scarring, and 9 = over ¾ of the root surface blackened by scarring or dead beet) of Campbell et al. (2000).

Harvest: Plots were harvested on 20 September in 2016, 3 October in 2017, and 25 September in 2018. Immediately (i.e., between 10 and 60 min) before harvest of each year, all foliage was removed from plots by using a commercial-grade mechanical defoliator. All beets from the center two rows of each plot were then extracted from soil using a mechanical harvester and weighed in the field using a digital scale. A representative subsample of 12-18 beets was collected from each plot and sent to the American Crystal Sugar Company Tare Laboratory (East Grand Forks, MN) for sucrose content and quality analysis.

Data analysis: All data from root injury ratings and harvest samples were subjected to analysis of variance (ANOVA) according to the general linear models (GLM) procedure (SAS Institute, 2012). Treatment means were compared by using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance. Initial analyses indicated that there were no significant treatment × year interactions for root injury ratings ($P = 0.7445$), recoverable sucrose yield ($P = 0.2636$), root yield ($P = 0.1345$), or percent sucrose content data ($P = 0.4321$). As such, three-year combined analyses were performed on all data from this experiment.

Results and Discussion:

Sugarbeet root maggot feeding injury results from this three-year trial are presented in Table 1. Moderate to high SBRM infestations were present during these evaluations, with the lowest feeding pressure occurring in 2017, and the highest occurring in 2018. The average SBRM feeding injury rating for the untreated check plots across study years was 6.37 on the 0 to 9 scale of Campbell et al. [2000]); however, the average feeding injury recorded for all insecticide-protected plots was significantly lower than that in the untreated check.

The lowest average root maggot feeding injury was observed in plots protected by the dual insecticide program comprised of Poncho Beta-treated seed plus a postemergence application of Mustang Maxx at 4 fl oz of product/ac. Other entries that were not significantly outperformed by this treatment included the following: 1) Poncho Beta plus a postemergence application of Lorsban Advanced at its high (2 pts product/ac) labeled rate; 2) Counter 20G at planting time at its moderate rate of 7.5 lb product/ac; and 3) Poncho Beta plus Movento HL, applied at 2.5 fl oz of product/ac at peak SBRM fly activity. There was no significant difference in SBRM feeding injury between applications of Movento HL made at peak fly activity and those made at about one week pre-peak.

Table 1. ***Larval feeding injury*** **in a comparison of Movento HL®, Lorsban Advanced, and Mustang Maxx for postemergence sugarbeet root maggot control, St. Thomas, ND, 2016 – 2017**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Root injury (0-9)
Poncho Beta + Mustang Maxx	Seed 2-3 d Pre-peak Broadcast	 4 fl oz	68 g a.i./ unit seed 0.025	4.07 d
Poncho Beta + Lorsban Advanced	Seed 2-3 d Pre-peak Broadcast	 2.0 pts	68 g a.i./ unit seed 1.0	4.23 cd
Counter 20G	B	7.5 lb	1.5	4.30 bcd
Poncho Beta + Movento HL + MSO	Seed Peak fly (or 1 d pre-peak)	 2.5 fl oz	68 g a.i./ unit seed 0.078	4.52 bcd
Poncho Beta + Movento HL + MSO	Seed 6-7 d Pre-peak Broadcast	 2.5 fl oz	68 g a.i./ unit seed 0.078	4.61 bc
Poncho Beta	Seed		68 g a.i./ unit seed	4.74 b
Check	-----	----	-----	6.37 a
LSD (0.05)				0.504

Means within a column sharing a letter are not significantly ($P = 0.05$) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Seed = insecticidal seed treatment

Yield data from this experiment are shown in Table 2. Similar to the results from root injury rating comparisons, all insecticide treatments provided significant increases in recoverable sucrose yield, root tonnage, and percent sucrose content in comparison to the untreated check.

The two best-performing treatments with regard to recoverable sucrose and root yield included the combination of Poncho Beta seed treatment plus a postemergence application of Lorsban Advanced at its high labeled rate of 2 pts product/ac, and Poncho Beta seed plus a postemergence application of Mustang Maxx at its high labeled rate (4 fl oz/ac).

These treatment programs produced averages of 3,207 and 2,810 lb more recoverable sucrose per acre, respectively than the untreated check throughout the three-year duration of this experiment. They also generated revenue increases of $438 and $395/ac, respectively, when compared to the check plots. Revenue benefits from Movento HL ranged from $9/ac for the peak fly application to $23/ac for the 7-day pre-peak application when compared to Poncho Beta plots that did not receive a postemergence spray. Increases in gross revenue from the postemergence applications of Lorsban Advanced and Mustang Maxx in plots initially protected by Poncho Beta-treated seed were $188 and $145/ac, respectively.

Table 2. *Yield parameters* from a comparison of Movento HL®, Lorsban Advanced, and Mustang Maxx for postemergence sugarbeet root maggot control, St. Thomas, ND, 2016 – 2017

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Poncho Beta + Lorsban Advanced	Seed 2-3 d Pre-peak Broadcast	2.0 pts	68 g a.i./ unit seed 1.0	8,714 a	28.7 a	16.2 a	1,012
Poncho Beta + Mustang Maxx	Seed 2-3 d Pre-peak Broadcast	4 fl oz	68 g a.i./ unit seed 0.025	8,317 a	27.4 ab	16.1 a	969
Poncho Beta + Movento HL + MSO	Seed 6-7 d Pre-peak Broadcast	2.5 fl oz	68 g a.i./ unit seed 0.078	7,532 b	25.4 bc	15.9 a	847
Poncho Beta + Movento HL + MSO	Seed Peak fly (or 1 d pre-peak)	2.5 fl oz	68 g a.i./ unit seed 0.078	7,397 b	24.9 c	15.7 a	833
Poncho Beta	Seed		68 g a.i./ unit seed	7,233 b	25.1 c	15.8 a	824
Counter 20G	B	7.5 lb	1.5	7,392 b	24.0 c	16.0 a	831
Check	-----	----	-----	5,507 c	19.5 d	15.1 b	574
LSD (0.05)				676.5	2.06	0.53	

Means within a column sharing a letter are not significantly (P = 0.05) different from each other (Fisher's Protected LSD test).
[a]B = banded at planting; Seed = insecticidal seed treatment

All insecticide treatments, whether comprised of a single planting-time application of Counter 20G, Poncho Beta seed treatment alone, or dual-insecticide programs that included Poncho Beta seed plus a postemergence insecticide spray, provided significant increases in percent sucrose content when compared to the untreated check. However, there were no significant differences in sucrose content among insecticide treatments.

The results from this three-year study show that, under moderate to moderately high SBRM infestation levels, major yield and revenue benefits can be achieved in control programs that combine a neonicotinoid seed treatment insecticide and a postemergence sprayable insecticide. Results also suggest that yields and revenue are markedly increased by the postemergence insecticide. Although there were no significant differences in regard to root protection from SBRM feeding activity or resulting yield parameters between the two timings tested for Movento HL applications, results suggest slight improvements by applying this product earlier. This pattern may have been due to the systemic movement of Movento within the plant. Applying it earlier may have resulted in higher concentrations of insecticide active ingredient in roots when SBRM larval feeding injury was occurring. Further research is needed to evaluate Movento under higher SBRM infestations to fully characterize its SBRM control capability. Research should also focus on optimizing Movento application timing and use rate. The EPA-approved label allows for a higher application rate of 4.5 fl oz/ac. It is uncertain at this time as to whether applying this product at its maximum labeled rate, if shown to be more efficacious, will be economically practical.

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EFFECTIVE SPRINGTAIL MANAGEMENT IN SUGARBEET WITH GRANULAR, SPRAYABLE LIQUID, AND SEED-APPLIED INSECTICIDES

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Introduction:

Subterranean (soil-dwelling) springtails have been recognized as serious pests of sugarbeet in the Red River Valley (RRV) of Minnesota and North Dakota since the late-1990s. In the past three to five years, producers in western ND and eastern Montana have also experienced serious crop damage associated with springtail feeding injury. Springtails belong to the order Collembola, an order of organisms that is so unique that they are considered by many experts to belong to a separate taxonomic group from that of true insects. These tiny, nearly microscopic, blind, and wingless insects spend their entire lives below the soil surface (Boetel et al. 2001).

Although subterranean springtails are present in many fields throughout the sugarbeet production areas of ND, MN, and eastern MT, they only occasionally become a major pest problem. These pests thrive in heavy soils with high levels of soil organic matter. Cool and wet weather can be conducive to springtail infestation buildups, because such conditions slow sugarbeet seed germination and seedling development, which renders plants extremely vulnerable to attack by springtails. Unfortunately, pest species of springtails do not appear to be negatively impacted by cool temperatures. Therefore, these pests can cause major plant stand and yield losses. This research was conducted to evaluate the performance of a conventional granular insecticide, an at-plant liquid insecticide, and three neonicotinoid insecticidal seed treatments for springtail control in sugarbeet.

Materials & Methods:

This field experiment was established on the NDSU Experiment Farm near Prosper, ND. Plots were planted on 16 May, 2018 using a 6-row Monosem NG Plus 7x7 planter set to plant at a depth of 1¼ inch and a rate of one seed every 4½ inches of row length. Betaseed 89RR52, a glyphosate-tolerant seed variety, was used for all treatments. Individual treatment plots were two rows (22-inch spacing) wide and 25 feet long, and 20-ft wide tilled alleys were maintained between replicates throughout the growing season. The experiment was arranged in a randomized complete block design with four replications of the treatments. Two-row plots are the preferred experimental unit size in springtail trials because infestations of these pests are typically patchy in distribution. Therefore, a smaller test area increases the likelihood of having a sufficiently uniform springtail infestation among plots within each testing replicate.

Insecticidal seed treatment materials were applied to seed by Germain's Technology Group (Fargo, ND). Granular insecticide treatments were applied by using band placement (Boetel et al. 2006), which consisted of 5-inch swaths that were delivered through Gandy™ row banders. Output rates of the planting-time standard granular material used this experiment were regulated by using a planter-mounted SmartBox™ computer-controlled insecticide delivery system that was calibrated on the planter immediately before all applications. Mustang Maxx was applied as a dribble in-furrow (DIF) application through microtubes directed into the open seed furrow by using a planter-mounted, CO_2-propelled spray system calibrated to deliver a finished spray volume output of 5 GPA. Teejet® No. 20 orifice plates were installed inline within check valves to achieve the correct spray output volume. Poncho Beta seed insecticidal treatment was also combined with a planting-time application of Mustang Maxx to comprise a single entry in the trial.

Treatments were compared by using plant stand counts and yield parameters because subterranean springtails can cause stand reductions that can lead to yield loss. Stand counts involved counting all living plants within each 25-ft long row. Plant stand counts were taken on 5 and 28 June, and 5 July, which were 20, 43, and 50 days after planting (DAP), respectively. Raw stand counts were converted to plants per 100 linear row ft for the analysis. Harvest operations, which were conducted on 18 September, involved initially removing the foliage from all plots by using a commercial-grade mechanical defoliator immediately (i.e., between 10 and 60 minutes) beforehand. Plots were harvested by using a 2-row mechanical harvester to collect all beets from both rows of each plot. Representative subsamples of 12-18 randomly selected beets were sent to the American Crystal Sugarbeet Quality Laboratory (East Grand Forks, MN) for quality analyses. All stand and yield data were subjected to analysis of variance (ANOVA) using the general linear models (GLM) procedure (SAS Institute, 2012), and treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.1 level of significance.

Results and Discussion:

Plant stand count data for this trial are presented in Table 1. Results from all stand count dates indicated that the higher rate (5.9 lb product/ac) of Counter 20G, all three insecticidal seed treatments, and the combination treatment consisting of Poncho Beta-treated seed plus Mustang Maxx, resulted in significantly greater numbers of surviving plants per 100 ft of row than the untreated check. There were no significant differences in plant stand protection among these treatments, irrespective of stand count date, throughout the growing season. The only treatments that did not provide significant levels of protection from springtail-associated stand losses were the lower (4.5 lb/ac) rate of Counter 20G and the Mustang Maxx treatment, and those deficiencies were consistent among stand count dates. However, it should be noted that there were no statistical differences in stand protection between the 5.9- and 4.5-lb application rates of Counter 20G at any of those dates.

Table 1. ***Plant stand counts*** **from evaluation of planting-time granular, liquid, and seed treatment insecticides for springtail control, Prosper, ND, 2018**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Stand count[b] (plants / 100 ft)		
				20 DAP[c]	43 DAP[c]	50 DAP[c]
Nipslt Inside	Seed		60 g a.i./ unit seed	178.3 a	194.2 a	194.6 a
Poncho Beta	Seed		68 g a.i./ unit seed	176.7 a	173.8 ab	191.7 a
Cruiser 5FS	Seed		60 g a.i./ unit seed	172.1 a	174.2 abc	183.3 a
Counter 20G	B	5.9 lb	1.2	176.7 a	174.2 abc	182.9 a
Poncho Beta + Mustang Maxx	Seed DIF	 4 fl oz	68 g a.i./ unit seed 0.025	171.3 a	182.9 ab	182.5 a
Counter 20G	B	4.5 lb	0.9	152.5 ab	157.9 bcd	165.4 ab
Check	---	----	---	137.9 b	138.8 d	143.8 bc
Mustang Maxx	DIF	4 fl oz	0.025	127.5 b	142.5 cd	130.0 c
LSD (0.1)				31.07	32.55	30.58

Means within a column sharing a letter are not significantly ($P = 0.1$) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; DIF = dribble in-furrow; Seed = insecticidal seed treatment
[b]Surviving plant stands were counted on 5 and 28 June, and on 5 July, 2018 (i.e., 20, 43, and 50 days after planting, respectively).
[c]DAP = Days after planting

Yield results from this experiment are presented in Table 2. The top-performing treatment, with regard to recoverable sucrose, root yield, and percent sucrose, was the combination involving Poncho Beta-treated seed plus Mustang Maxx applied via dribble-in-furrow placement. Other treatments in the study that produced recoverable sucrose and root yields that were not statistically different from this entry included the following: 1) Cruiser; 2) NipsIt Inside; 3) Poncho Beta; and 4) Mustang Maxx. As observed in stand count results, there were no significant differences between Counter 20G application rates for any of the measured yield parameters. Overall, the only entries in the experiment that resulted in significant increases in both recoverable sucrose yield and root tonnage were the combination treatment of Poncho Beta seed plus Mustang Maxx, Cruiser, and NipsIt Inside.

Table 2. ***Yield parameters*** **from evaluation of planting-time granular, liquid, and seed treatment insecticides for springtail control, Prosper, ND, 2018**

Treatment/form.	Placement[a]	Rate (product/ac)	Rate (lb a.i./ac)	Sucrose yield (lb/ac)	Root yield (T/ac)	Sucrose (%)	Gross return ($/ac)
Poncho Beta + Mustang Maxx	Seed DIF	 4 fl oz	68 g a.i./ unit seed 0.025	11,957 a	40.8 a	16.03 a	1,375
Cruiser 5FS	Seed		60 g a.i./ unit seed	11,340 ab	40.0 ab	15.70 a	1,236
Nipslt Inside	Seed		60 g a.i./ unit seed	11,025 ab	38.9 ab	15.78 a	1,202
Poncho Beta	Seed		68 g a.i./ unit seed	10,817 abc	38.0 ab	15.80 a	1,186
Mustang Maxx	DIF	4 fl oz	0.025	10,756 abc	38.1 ab	15.65 a	1,167
Counter 20G	B	5.9 lb	1.2	10,521 bc	36.6 bc	15.85 a	1,174
Counter 20G	B	4.5 lb	0.9	10,079 bc	36.1 bc	15.53 a	1,069
Check	---	----	---	9,680 c	33.3 c	15.90 a	1,102
LSD (0.1)				1,304.0	4.01	NS	

Means within a column sharing a letter are not significantly ($P = 0.1$) different from each other (Fisher's Protected LSD test).
[a]B = 5-inch band; DIF = dribble in-furrow; Seed = insecticidal seed treatment

Gross economic return results from this trial followed similar patterns to those for recoverable sucrose and root yields. The Mustang-alone treatment generated $1,167 in gross economic return, which was a revenue gain of $65/ac over that of the untreated check; however, combining Mustang with Poncho Beta-treated seed generated $1,375/ac in gross revenue, which was $273/ac more revenue than the untreated check and $189/ac more than that from plots protected solely by Poncho Beta-treated seed, and $208/ac more revenue than the Mustang-only plots.

Insecticidal seed treatments (i.e., Cruiser, NipsIt Inside, or Poncho Beta) produced revenue gains that ranged from $84 to $134/ac when compared to the untreated check plots. Plots treated with the 5.9-lb rate of Counter 20G generated $72/ac more gross revenue than the untreated check plots; however, there was no net gain in gross revenue from plots treated with the lower rate (4.5 lb product/ac) of Counter.

Collectively, the yield and gross revenue increases generated by insecticide treatments in this experiment clearly demonstrate that effective tools are available to producers for managing subterranean springtails in sugarbeet. These findings also illustrate the economic significance of subterranean springtails as sugarbeet pests and demonstrate the benefits that can be achieved by effectively managing them, even under moderate springtail infestations such as that which was present for this experiment.

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The authors greatly appreciate the contributions of Clara Jastram, Rachel Stevens, Kenan Stoltenow, Claire Stoltenow, and Juliana Hanson for assistance with plot maintenance and data collection. Sincere gratitude is extended to the Sugarbeet Research and Education Board of Minnesota and North Dakota for providing significant funding to support this project. This work was also partially supported by the U.S. Department of Agriculture, National Institute of Food and Agriculture, under Hatch project accession number 1012990.

Entomology Appendix A.: Agronomic, Rainfall, and Plot Maintenance Information

Location:	St. Thomas (Pembina County), ND – Wayne Lessard Farm – *Sugarbeet Root Maggot Trials*	
Plot size:	Six 35-ft long rows (4 center rows treated)	
Design:	Randomized complete block, 4 replications	
Soil name:	Glyndon silt loam	
Soil test:	Organic matter = 3.2%	pH = 8.1
Soil texture:	19.0% sand 62.0% silt	19.0% clay
Previous crop:	Wheat (2017)	
Soil preparation:	Field cultivator (1x)	
Planting depth:	1.25"	
Herbicides applied:	June 4	Roundup PowerMAX (32 fl oz/ac) + Veracity Elite (3 qt/100 gal)
	June 27	Cornerstone 5 Plus (1.5 pt/ac) + Interlock (6 fl oz/ac) + Class Act NG (2.5% v/v)
Rainfall (after seedbed preparation)**:**	May 17	0.09"
	May 18	1.13"
	May 23	0.38"
	May 27	0.04"
	May 30	0.34"
	Total/May	**1.61"**
	June 1	0.76"
	June 2	0.06"
	June 8	0.89"
	June 11	0.21"
	June 14	0.37"
	June 15	0.44"
	June 23	0.45"
	June 25	0.10"
	June 29	0.40"
	Total/June	**3.68"**
	July 1	0.39"
	July 3	0.04"
	July 4	0.85"
	July 8	0.01"
	July 26	0.37"
	July 29	0.21"
	Total/July	**1.87"**
	Total/August	**0.57"**
	Total/September	**1.73"**
Damage ratings:	July 30-31	
Harvest date:	September 24-25	
Yield sample size:	2 center rows x 35 ft length (70 row-ft total)	

Location:	Thompson (Grand Forks County), ND – Tim Myron Farm – *Sugarbeet Root Maggot Trials*	
Plot size:	Six 35-ft long rows (4 center rows treated)	
Design:	Randomized complete block, 4 replications	
Soil name:	Glyndon silt loam	
Soil test:	Organic matter = 4.0%	pH = 8.0
Soil texture:	2.6% sand 70.4% silt	27.0% clay
Previous crop:	Potatoes (2017)	
Soil preparation:	Field cultivator (1x)	
Planting depth:	1.25"	
Herbicides applied:	June 20	Roundup PowerMAX (32 fl oz/ac) + Veracity (3 qt/100 gal)
Fungicide applied:	Aug 23	Agritin (5 fl oz/ac) + Activator 90 (2 pt/100 gal) + Surfactant (3.2 fl oz/ac)

Rainfall (after seedbed preparation)**:**	May 17	0.66"
	May 18	0.17"
	May 27	0.14"
	May 27	0.11"
	Total/May	**1.08"**
	June 1	0.47"
	June 2	0.10"
	June 5	0.48"
	June 8	1.62"
	June 11	1.42"
	June 17	0.13"
	June 23	0.32"
	June 24	0.31"
	June 29	0.40"
	Total/June	**5.25"**
	July 1	0.10"
	July 3	1.15"
	July 4	0.51"
	July 8	0.18"
	July 22	0.93"
	Total/July	**2.87"**
	Total/August	**1.34"**
	Total/September	**2.48"**

Damage ratings: August 2
Harvest date: September 20
Yield sample size: 2 center rows x 35 ft length (70 row-ft total)

Location:	Prosper (Cass County), ND – NDSU Experiment Farm – *Springtail Management Trial*	
Plot size:	Two 25-ft long rows	
Design:	Randomized complete block, 4 replications	
Soil name:	Bearden-Lindaas silty clay loam	
Soil test:	Organic matter = 3.8% pH = 8.1	
Soil texture:	16.3% sand 52.0% silt 31.7% clay	
Previous crop:	Wheat (2017)	
Soil preparation:	Field cultivator (2x)	
Planting depth:	1.25"	
Herbicides applied:	May 31	Roundup PowerMAX (32 fl oz/ac) + Class Act NG (2.5% v/v)
	June 19	Roundup PowerMAX (32 fl oz/ac) + Class Act NG (2.5% v/v)
Fungicides applied:	May 29	Quadris (14.3 fl oz ac)
	June 19	Quadris (14.3 fl oz ac)
	July 13	Agritin (8 oz/ac) + Topsin 4.5FL (10 fl oz/ac)
	July 27	Agritin (8 oz/ac) + Inspire XT (7 fl oz/ac)
	Aug 10	Badge SC (2 pt/ac) + Manzate (1.6 qt/acre)
	Aug 30	Supertin (8 fl oz/ac) + Proline (5.7 fl oz/ac) + Prefer 90 (0.125% v/v)
Rainfall: (after seedbed preparation):	May 17	1.15"
	May 27	0.15"
	May 30	0.32"
	Total/May	**1.62"**
	June 2	0.18"
	June 5	0.64"
	June 11	1.01"
	June 16	0.32"
	June 23	0.20"
	June 24	0.16"
	June 29	0.61"
	Total/June	**3.12"**
	July 2	0.31"
	July 3	0.37"
	July 4	0.75"
	July 6	0.12"
	July 10	0.23"
	July 19	0.54"
	July 22	0.17"
	July 25	0.08"
	Total/July	**2.57"**
	Total/August	**2.99"**
	Total/September	**1.17"**
Stand counts:	June 5 and 29; July 5	
Harvest date:	September 18	
Yield sample size:	2 rows x 25 ft length (50 row-ft total)	

Entomology Appendix B. 0 to 9 Scale for Rating Sugarbeet Root Maggot Feeding Injury

Treatment performance in preventing sugarbeet root maggot feeding injury was quantified for all root maggot control trials by rating beets on the 0 to 9 root injury rating scale of Campbell et al. (2000). Criteria for respective points on the scale are as follows:

0 = no scars

1 = 1 to 4 small (pin head size) scars

2 = 5 to 10 small scars

3 = 3 large scars or scattered small scars

4 = few large scars and /of numerous small scars

5 = several large scars and/or heavy feeding on laterals

6 = up to 1/4 root scarred

7 = 1/4 to 1/2 of root blackened by scars

8 = 1/2 to 3/4 root blackened by scars

9 = more than 3/4 of root area blackened

Reference Cited:

Campbell, L. G., J. D. Eide, L. J. Smith, and G. A. Smith. 2000. Control of the sugarbeet root maggot with the fungus *Metarhizium anisopliae*. J. Sugar Beet Res. 37: 57–69.

PLANT PATHOLOGY

NOTES

TURNING POINT SURVEY OF FUNGICIDE USE IN SUGARBEET IN MINNESOTA AND EASTERN NORTH DAKOTA IN 2017

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The third~~second~~ annual fungicide practices live polling questionnaire was conducted using Turning Point Technology at the 2018 Winter Sugarbeet Growers' Seminars. Responses are based on production practices from the 2017 growing season. The survey focuses on responses from growers in attendance at the Fargo, Grafton, Grand Forks, Wahpeton, ND and Willmar, MN Grower Seminars. Respondents from each seminar indicated the county in which the majority of their sugarbeets were produc~~t~~ed (Tables 1- 5). The average sugarbeet acreage per respondent grown in 2017 was calculated from Table 6 at between 400 and 599 acres acres.

Survey participants were asked about soil-borne diseases and control practices. Seventy eight percent ~~percent~~ said their fields were affected by R~~r~~hizoctonia, 8% said ~~r~~they had no soil borne disease issues, 7% said Aphanomyces was the biggest issues, 6% said they had issues with multiple diseases including Rhizoctonia, Aphanomyces, Fusarium and Rhizomania and 1% each listed either Fusarium or Rhizomania as their biggest issue (Table 7).

Participants were asked what methods were used to control R~~r~~hizoctonia and 52% said they used a seed treatment only, 41% used a seed treatment and a POST fungicide, 4% used a seed treatment plus an in-furrow fungicide while 4% also said they used a seed treatment, in-furrow fungicide and a POST fungicide (Table 8). Seventy one percent of respondents used a Kabina seed treatment while 14% used a Rizolex + Metlock + Kabina mixture, 8% used a Systiva seed treatment, 4% used a Vibrance seed treatment and 3% reported using no seed treatment to control rhizoctonia (Table 9). Seventy seven percent of respondents did not use an in-furrow fungicide but 18% of respondents used Quadris (or generic) in-furrow, 1% used Headline (or generic) in-furrow to control R~~r~~hizoctonia and 5% used a different fungicide (Table 10).

Respondents were asked what POST fungicides were used to control R~~r~~hizoctonia and ~~the plurality,~~ 41%~~,~~ did not use a POST fungicide to control R~~r~~hizoctonia. Of the remaining 59%, 47% used Quadris, 6% used Proline, 3% used Priaxor, 1% used Headline while 1% used a different fungicide (Table 11). Participants were then asked to grade the effectiveness of the POST fungicides that were used. Thirty nine percent said they received good results, 36% said they were unsure of their results, 11% reported excellent results, another 11% said the fungicides performed fair and 3% said they performed poorly (Table 12).

Growers were asked if they applied any type of in-furrow starter fertilizer. Eighty two percent of respondents said that they did apply in-furrow starter fertilizer while 18% did not (Table 13).

Participants were also asked about use of waste lime to control A~~a~~phanomyces. Sixty six percent of participants did not use waste lime in their fields while 22% used between 6 and 10 tons/acre while 13% used less than 5 tons/acre (Table 14). Respondents were also asked about their soil pH. Forty percent said it was between 7.5 and 8.0, 34% said between 8.0 and 8.5, 15% between 7.0 and 7.5, 7% between 6.5 and 7.0 2% said between 6.0 and 6.5 and another 2% said between 8.5 and 9.0 (Table 15). As a follow-up question, growers were asked whether or not they were concerned about using waste lime on soils above 8.0 pH. Seventy seven percent said no while the remaining 23% said they were concerned (Table 16).

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Finally, the growers were asked how effective their waste lime was. Fifty seven percent of respondents did not apply lime, 17% said they had good results, 16% said excellent, 6% were unsure and 3% reported fair results (Table 17).

Survery participants were then asked a series of questions regarding their CLS fungicide practices on sugarbeet in 2017. Twenty percent said that they used 5 sprays to control CLS, 19% used four applications, 18% used three applications, 15% used two applications, 12% used six applications, 7% used seven applications, 6% used one application, 2% did not use a CLS application and 1% applied more than seven CLS applications (Table 18). Respondents were then asked about the effectiveness of their CLS sprays. Fifty four percent said they had good results, 34% said they had excellent results, 10% reported fair results, 2% were unsure and 1% said they had poo results (Table 19). Participants were then asked if they experienced field failure and what date that occurred. Seventy six percent said they did not experience field failure, 8% said it occurred around August 31, 6% said September 15, 4% said September 30, 3% said August 15, 2% said after September 30 and 1% said July 31 (Table 20).

Respondents were asked about when their CLS application started and ended. Forty six percent of participants said that they began their applications between July 1 and 10, 22% said it started between July 11 and 20, 16% said it was between July 21 and 31, 10% said before July 1, 4% said that CLS sprays started between August 1 and 10 and 1% said after August 10 (Table 21). Forty nine percent of respondents said that their last CLS spray was between September 1 and 10, 23% said between August 21 and 31, 20 said between September 11 and 20, 6% said between August 11 and 20, 2% said after September 20 and 1% said they only made one or zero CLS applications (Table 22).

Participants were then asked about their specific fungicide use to control CLS. Sixty two percent of growers said that their first application was Tin + Topsin, 17% said EBDC + Triazole, Tin + Triazole, 5% said Tin + QOI, 4% said they used a single chemistry application, 3% said Triazole + QOI and 1% said EBDC + QOI. (Table 23). For the second application, 40% of respondents said they used Tin + Topsin, 34% said EBDC + Triazole, 8% said Tin + QOI, 5% said Tin + Triazole, 4% used a single chemistry application, 3% said Triazole + QOI and 2% each said EBDC + QOI, EPDC + Copper and Other while 1% said they sprayed Triazole + Copper for the second application (Table 24). For the third application, 19% said EBDC + Triazole, 15% said a single chemistry application, 13% aid Tin + QOI, 12% said Tin + Triazole and EBDC + QOI, 11% said EBDC + Copper, 6% said Triazole + QOI, 4% said Triazole + Copper as well as Other and 3% used Tin + Topsin for the third CLS application in 2018 (Table 25). For the fourth application, 24% applied Tin + Topsin, 15% used Tin + Triazole, 14% used a single chemisty application, 11% used an EBDC + Triazole, 8% used an EBDC + QOI, 7% used Tin + QOI and Other, 6% said they used Triazole + QOI, 4% used EBDC + Copper and and 3% used Triazole + Copper for the fourth application (Table 26). For the fifth application in 2017, 28% used a single chemistry application, 20% used Tin + Topsin, 15% used an EBDC + QOI, 13% used EBDC + Copper, 8% used Tin + QOI and Triazole + Copper and 5% each used Tin + Triazole and Triazole + QOI (Table 27). For the sixth application, 64% of used a single chemistry application and 7% used Tin + Topsin, EBDC + QOI, EBDC + Copper, Triazole + QOI and Trizaole + Copper (Table 28). For the seventh application in 2017, 44% of respondents used a single chemistry application, 22% used Triazole + QOI and 11% each used Tin + Topsin, Tin + Triazole and Triazole + Copper in 2017 (Table 29).

Table 1. 2018 Fargo Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Barnes	-	-
Becker	2	4
Cass	7	14
Clay	11	23
Norman[1]	22	45
Ransom	-	-
Richland	1	2
Steele	1	2
Trail	4	8
Wilkin[2]	1	2
Total	34	100

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

Table 2. 2018 Grafton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Cavalier	-	-
Grand Forks	5	8
Kittson	7	12
Marshall	5	8
Nelson	-	-
Pembina	16	27
Polk	1	2
Ramsey	1	2
Walsh	25	42
Other	-	-
Total	60	100

Table 3. 2018 Grand Forks Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Grand Forks	23	28
Mahnomen	1	1
Marshall	10	12
Nelson	-	-
Pennington/Red Lake	-	-
Polk	35	43
Steele	-	-
Traill	4	5
Walsh	3	4
Other	5	6
Total	81	100

Table 4. 2018 Wahpeton Grower Seminar – Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Cass	-	-
Clay	2	5
Grant	5	12
Otter Tail	-	-
Ransom	-	-
Richland	10	24
Roberts	-	-
Stevens	-	-
Traverse	2	5
Wilkin	22	54
Total	41	100

Table 5. 2018 Willmar Grower Seminar - Number of survey respondents by county growing sugarbeet in 2017.

County	Number of Responses	Percent of Responses
Chippewa	34	34
Kandiyohi	15	15
Pope	-	-
Redwood	5	5
Renville	31	31
Stearns	-	-
Stevens	4	4
Swift	7	7
Other	4	4
Total	100	100

Table 6. Total sugarbeet acreage operated by respondents in 2017.

		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	46	4	4	4	22	20	15	9	9	7	7
Grafton	56	4	14	7	20	23	14	5	7	4	2
Grand Forks	72	6	8	10	14	22	13	11	10	1	6
Wahpeton	40	-	13	13	15	15	13	18	10	3	3
Willmar	99	1	12	13	8	24	17	5	13	4	2
Total	313	3	11	10	14	22	15	9	10	4	4

Table 7. What soil-borne diseases affected your sugarbeet production in 2017?

Location	Respondents	Root disease					
		Rhizoctonia	Aphanomyces	Fusarium	Rhizomania	All	Neither
		-----------------------------% of respondents------------------------					
Fargo	47	70	11	-	-	13	6
Grafton	54	72	15	-	6	-	7
Grand Forks	79	85	3	1	-	5	6
Wahpeton	44	82	5	-	-	5	9
Willmar	101	76	6	1	-	6	11
Total	325	78	7	1	1	6	8

Table 8. What methods were used to control *Rhizoctonia solani* in 2017?

Location	Respondents	Seed Treatment Only	Seed Treatment + In-Furrow	Seed Treatment + POST	Seed Treatment + In-Furrow + POST
		--------------------% respondents--------------------			
Fargo	44	57	2	36	5
Grafton	54	28	6	61	6
Grand Forks	81	42	6	47	5
Wahpeton	45	82	4	13	-
Willmar	100	56	1	40	3
Total	324	52	4	41	4

Table 9. Which seed treatment did you use to control *Rhizoctonia solani* in 2017?

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Location	Respondents	Seed treatment				
		Kabina	Rizolex + Metlock + Kabina	Vibrance	Systiva	None
		------------------------------% of respondents---------------------------				
Fargo	40	83	13	-	3	3
Grafton	53	60	13	8	13	6
Grand Forks	80	65	20	4	10	1
Wahpeton	41	88	5	2	2	2
Total	214	71	14	4	8	3

Table 10. Which fungicide did you apply in-furrow to control *R. solani* in 2017?

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Location	Respondents	In-furrow fungicide use			
		Headline or generic	Quadris or generic	Other	None
		-----------------------------% of respondents---------------------------			
Fargo	45	2	7	2	89
Grafton	53	-	15	4	81
Grand Forks	74	4	10	-	87
Wahpeton	42	-	2	-	98
Willmar	96	4	13	1	82
Total	310	1	18	5	77

Table 11. Which POST fungicide did you use to control *R. solani* in 2017?

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Location	Respondents	POST fungicide					
		Headline	Quadris	Proline	Priaxor	Other	None
		-------------------------------% of respondents----------------------------					
Fargo	43	2	54	2	7	2	33
Grafton	51	-	71	2	6	-	22
Grand Forks	79	1	62	5	3	1	28
Wahpeton	42	5	12	5	-	2	77
Willmar	99	-	36	10	2	-	52
Total	314	1	47	6	3	1	41

Table 12. How effective were your POST fungicides at controlling *Rhizoctonia solani* in 2017?

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Location	Respondents	Effectiveness of fungicides				
		Excellent	Good	Fair	Poor	Unsure
		-------------------------------% of respondents----------------------------				
Fargo	36	3	58	8	8	22
Grafton	50	14	60	14	-	12
Grand Forks	64	28	45	6	2	19
Wahpeton	32	6	3	19	3	69
Willmar	91	2	28	12	2	56
Total	273	11	39	11	3	36

Table 13. Did you apply any in-furrow starter fertilizer in 2017?

Location	Respondents	Variety type	
		Yes	No
		---------------------% respondents---------------------	
Fargo	45	91	9
Grafton	56	79	21
Grand Forks	83	89	11
Wahpeton	45	51	49
Willmar	101	86	14
Total	330	82	18

Table 14. What rate of precipitated calcium carbonate (waste lime) did you use in 2017?

Location	Respondents	Lime use rate		
		None	>5 T/A	6-10 T/A
		-------------------------------% of respondents----------------------------		
Fargo	42	67	2	31
Grafton	50	70	-	30
Grand Forks	80	86	-	14
Wahpeton	45	36	16	49
Willmar	102	60	31	9
Total	319	66	13	22

Table 15. What is your soil pH?

		Soil pH					
Location	Respondents	6.0-6.5	6.5-7.0	7.0-7.5	7.5-8.0	8.0-8.5	8.5-9.0
		-------------------------------% of respondents----------------------------					
Fargo	45	2	2	16	40	38	2
Grafton	50	2	16	16	34	30	2
Grand Forks	79	3	6	11	35	42	3
Wahpeton	42	-	2	19	57	21	-
Total	216	2	7	15	40	34	2

Table 16. Are you concerned about using waste lime on pH soils above 8.0?

		Safety concerns	
Location	Respondents	Yes	No
		---------------------% respondents---------------------	
Fargo	43	40	61
Grafton	51	26	75
Grand Forks	72	19	81
Wahpeotn	43	12	88
Total	209	23	77

Table 17. How effective was waste lime at controlling Aaphanomyces in 2017?

		Waste lime effectiveness					
Location	Respondents	Excellent	Good	Fair	Poor	Unsure	No Lime
		-------------------------------% of respondents----------------------------					
Fargo	47	13	17	2	-	9	60
Grafton	50	12	16	2	-	6	64
Grand Forks	76	11	9	1	-	3	76
Wahpeton	43	35	33	9	-	9	14
Total	216	16	17	3	0	6	57

Table 18. How many fungicide application did you make to control CLS in 2017?

		Number of applications								
Location	Respondents	0	1	2	3	4	5	6	7	>7
		-----------------------------% of respondents-------------------------								
Fargo	46	2	2	22	33	28	7	4	-	2
Grafton	55	4	18	42	36	-	-	-	-	-
Grand Forks	80	1	9	19	25	36	8	3	-	-
Wahpeton	46	-	-	2	9	26	59	4	-	-
Willmar	98	1	-	-	-	7	31	35	24	3
Total	325	2	6	15	18	19	20	12	7	1

Table 19. How effective were your fungicide applications on CLS in 2017?

Location	Respondents	Effectiveness of CLS sprays					
		Excellent	Good	Fair	Poor	Unsure	No applications
		-----------------------------% of respondents------------------------					
Fargo	43	35	54	9	-	-	2
Grafton	54	41	56	-	-	4	-
Grand Forks	79	71	27	1	-	1	-
Wahpeton	46	4	80	13	-	2	-
Willmar	99	14	62	20	3	1	-
Total	321	34	54	10	1	2	0

Table 20. When did you experience failure of fungicides to control CLS in 2017?

Location	Respondents	Date of fungicide failure						
		No failure	July 31	August 15	August 31	September 15	September 30	After September 30
		-----------------------------% of respondents------------------------						
Fargo	42	98	-	-	-	-	-	2
Grafton	50	100	-	-	-	-	-	-
Grand Forks	76	99	-	-	-	-	1	-
Wahpeton	46	70	2	4	11	7	4	2
Willmar	94	39	3	6	22	16	9	4
Total	308	76	1	3	8	6	4	2

Table 21. What date was your first CLS application?

Location	Respondents	Date of first CLS application					
		Before July 1	July 1-10	July 11-20	July 21-31	August 1-10	After August 10
		-----------------------------% of respondents-----------------------------					
Fargo	45	2	24	36	33	2	2
Grafton	52	-	14	29	42	15	-
Grand Forks	78	1	47	28	17	5	1
Wahpeton	46	9	72	17	-	-	2
Willmar	98	28	61	10	1	-	-
Total	319	10	46	22	16	4	1

Table 22. What date was your last CLS application in 2017?

		Date of last CLS application							
Location	Respondents	Before August 1	August 1-10	August 11-20	August 21-31	Sept 1-10	Sept 11-20	Later than Sept 20	Made zero or 1 CLS applications
		--------% of respondents--------							
Fargo	43	-	-	5	35	47	12	2	-
Grafton	52	-	-	14	23	54	8	-	2
Grand Forks	76	-	1	5	28	50	9	3	4
Wahpeton	41	-	-	-	37	51	12	-	-
Willmar	96	-	-	4	7	45	42	2	-
Total	308	0	0	6	23	49	20	2	1

Table 23. What fungicides did you apply with your first CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		--------% of respondents--------									
Fargo	38	40	-	34	11	-	-	3	-	11	3
Grafton	48	69	4	6	8	2	2	8	-	-	-
Grand Forks	73	51	11	26	5	1	-	1	-	4	-
Wahpeton	42	93	2	-	-	-	-	-	2	2	-
Total	201	62	5	17	6	1	0	3	0	4	0

Table 24. What fungicides did you apply with your second CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		--------% of respondents--------									
Fargo	36	58	3	22	6	-	-	3	3	6	-
Grafton	42	45	14	17	7	7	-	2	-	7	-
Grand Forks	67	49	3	31	3	2	3	3	2	2	3
Wahpeton	40	3	13	65	5	-	5	3	-	5	3

Total	185	40	8	34	5	2	2	3	1	4	2

Table 25. What fungicides did you apply with your third CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		------------------------------% of respondents------------------------------									
Fargo	36	3	8	31	14	8	3	6	3	25	-
Grafton	33	-	24	9	3	9	3	9	-	36	6
Grand Forks	57	7	16	23	21	18	-	7	2	4	4
Wahpeton	35	-	3	9	6	11	46	3	11	3	9
Total	161	3	13	19	12	12	11	6	4	15	4

Table 26. What fungicides did you apply with your fourth CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		------------------------------% of respondents------------------------------									
Fargo	19	11	5	5	5	5	5	21	5	37	-
Grafton	1	-	-	-	-	100	-	-	-	-	-
Grand Forks	41	5	15	15	20	12	2	2	-	17	12
Wahpeton	38	53	-	11	16	3	5	3	5	-	5
Total	99	24	7	11	15	8	4	6	3	14	7

Table 27. What fungicides did you apply with your fifth CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		------------------------------% of respondents------------------------------									
Fargo	5	-	20	-	-	20	20	20	-	20	-
Grafton	1	-	100	-	-	-	-	-	-	-	-
Grand Forks	14	14	7	-	7	29	-	-	-	43	-

Wahpeton	20	30	-	-	5	5	20	5	15	20	-
Total	40	20	8	-	5	15	13	5	8	28	-

Table 28. What fungicides did you apply with your sixth CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		------------------------------% of respondents------------------------------									
Fargo	3	-	-	-	-	33	-	-	33	33	-
Grafton	-	-	-	-	-	-	-	-	-	-	-
Grand Forks	7	-	-	-	-	-	14	14	-	71	-
Wahpeton	4	25	-	-	-	-	-	-	-	75	-
Total	14	7	-	-	-	7	7	7	7	64	-

Table 29. What fungicides did you apply with your seventh CLS application in 2017?

		Fungicide									
Location	Respondents	Tin + Topsin	Tin + QOI	EBDC + Triazole	Tin + Triazole	EBDC + QOI	EBDC + Copper	Triazole + QOI	Triazole + Copper	Single Chemistry	Other
		------------------------------% of respondents------------------------------									
Fargo	-	-	-	-	-	-	-	-	-	-	-
Grafton	-	-	-	-	-	-	-	-	-	-	-
Grand Forks	3	33	-	-	-	-	-	-	-	67	-
Wahpeton	6	-	-	-	17	-	-	33	17	33	-
Total	9	11	-	-	11	-	-	22	11	44	-

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). Disease can occur throughout the growing season and reduces plant stand, root yield, and quality (3). Warm and wet soil conditions favor infection. 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 management strategy should take advantage of multiple control options to reduce Rhizoctonia crown and root rot.

OBJECTIVES

A field trial was 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 yield and quality of sugarbeet.

MATERIALS AND METHODS

The trial was established at three locations, one at the University of Minnesota, Northwest Research and Outreach Center, Crookston, one at Wahpeton (MDFC), ND and one at Renville (SMBSC), 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), or untreated was planted in four replicate plots. 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 4.0 and 4.8, respectively (6).

NWROC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley broadcast at 50 kg ha^{-1} and incorporated with a Rau seedbed finisher. The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 04 at 4.5-inch seed spacing. Counter 20G (8.9 lb/A) was applied at planting and Lorsban (1 pt/A) was applied on June 4 for control of root maggot. Sequence (glyphosate + S-metolachlor, 2.5 pt/A) was applied on May 24 and glyphosate (4.5 lb product ae/gallon) was applied on May 31 and June 19 (28 oz/A), and July 9 (32 oz/A) for control of weeds. Postemergence azoxystrobin timings were applied in a 7-inch band in 10 gallon/A using 4002 nozzles and 34 psi on June 4 (4-6 leaf stage, ~4.5 weeks after planting) or June 19 (8-10 leaf stage, ~6.5 weeks after planting).

Cercospora leaf spot was controlled by Supertin + Topsin M (6 + 10 oz/A) on August 2 applied in 17 gallons water/A with 8002 flat fan nozzles at 90 psi.

MDFC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley (50 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 24 at 4.5-inch seed spacing. Roundup PowerMax (5.5 lb product ae/gallon) tank-mixed with N-tense (10 oz A^{-1}) and Outlook (18 oz A^{-1}) was applied on June 22. Postemergence azoxystrobin was applied in a 7-inch band on June 26 (4-leaf stage, 4 weeks after planting) or July 6 (8-leaf stage, 5.5 weeks after planting). Cercospora leafspot was controlled by separate applications of Inspire XT + Badge SC (7 oz A^{-1} & 16 oz A^{-1}, respectively) on July 24, Super Tin + Manzate (8 fl. oz A^{-1} & 51.2 fl. oz A^{-1}, respectively) on Aug 07, Minerva + Manzate (13 fl oz A-1 & 38.4 oz A-1 on Aug 17, and Super Tin + Badge SC (8 fl oz. A^{-1} & 32 oz A^{-1}) on Aug 29. 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 = 4.0) and moderately susceptible (2-year average rating = 4.8) 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	Kabina ST	Penthiopyrad	14 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 2017 crop season based on weather stations.

	Precipitation in inches		
Month	NWROC	MDFC	SMBSC
May	1.72	0.60	3.12
June	7.82	5.34	6.33
July	1.47	4.53	6.92
August	1.67	3.39	2.03
September	2.31	2.34	9.17
October (01-23)			2.63
Total	**14.99**	**16.20**	**30.20**

SMBSC site. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley (50 kg ha^{-1}). The trial was sown in six-row plots (22-inch row spacing, 30-ft rows) on May 16 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 Dual Magnum (8 oz A^{-1}) on May 17, Powermax (28 oz A^{-1}) + Dual magnum (16 oz A^{-1}) on June 8 and Powermax (22 oz A^{-1}) + Dual Magnum (16 ozA^{-1}) on June 28. Postemergence azoxystrobin timings were applied on June 05 (4-leaf, ~3 weeks after planting), or June 22 (8-leaf, ~5 weeks after planting) as 7 inch bands using 4001E nozzles at 35 psi. Fungicides were applied for controlling Cercospora leaf spot on July 11 (TPTH + Topsin, 8 & 20 oz A^{-1}, respectively), July 24 (Inspire XT + Dithane F-45, 7 & 32 oz A^{-1}, respectively), Aug 03 (TPTH + Badge SC, 8 & 32 oz A^{-1}, respectively), Aug 09 (Dithane F-45, 51.2 oz A^{-1}), Aug 17 (Minerva + Badge SC, 13 & 32 oz A^{-1}, respectively) and Aug 29 (Supertin + Dithane F-45, 8 & 51.2 oz A^{-1}, respectively). All fungicides for CLS control were applied in a water volume of 19.3 GPA with 11002 nozzles at 70 psi.

At NWROC stand counts were done beginning 2 weeks after planting through 8 weeks after planting. At MDFC stand counts were done 4 through 7 weeks after planting. At SMBSC stand counts were done 3 and 5 weeks after planting. The trial was harvested on Sept 18 at the NWROC, Oct 02 at Wahpeton and Oct 24 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 2018 growing season was drier at the NWROC during the period of April- May resulting in lower early season disease pressure. Rainfall at the NWROC was just 1.72 inch during the month of May compared to a 30-year average of 3.04 inches. Resistant and moderately resistant varieties had similar stands from 2 to 8 weeks after planting (WAP). Systiva treatment had higher stands from 3 to 7 WAP compared to Quadris in-furrow and control treatments. At 8 WAP Systiva had higher stands, intermediate for Quadris in-furrow and lowest for control treatments (Fig. 1). Control plots had 184 plants/100 ft. row at 8 WAP indicating very low early season disease pressure at this site. There was a significant variety x postemergence treatment interaction for root rot incidence and number of harvestable roots per 100 ft. Resistant variety had significantly lower incidence of Rhizoctonia root rot compared to the moderately resistant variety (Table 3). Even though enough rainfall was received in the month of June, relatively dry conditions during Jul-Sept resulted in very low disease pressure as reflected in the root rot ratings at harvest. There were no significant differences between Quadris in-furrow, Systiva seed treatment or control treatments for any harvest parameters (Table 3). Both 4- and 8-leaf Quadris applications resulted in significant reduction in root rot, increase in yield, percent sucrose, recoverable sugar A^{-1} (RSA), and recoverable sucrose T^{-1} (RST) compared to control (Table 3). Similar benefit from postemergence Quadris application was also evident in 2016 and 2017 (4,5). Root rot incidence was lower in the resistant variety compared to the susceptible variety (Fig. 2) and Quadris postemergence application reduced root rot incidence in the susceptible variety compared to no Quadris application (Fig. 2).

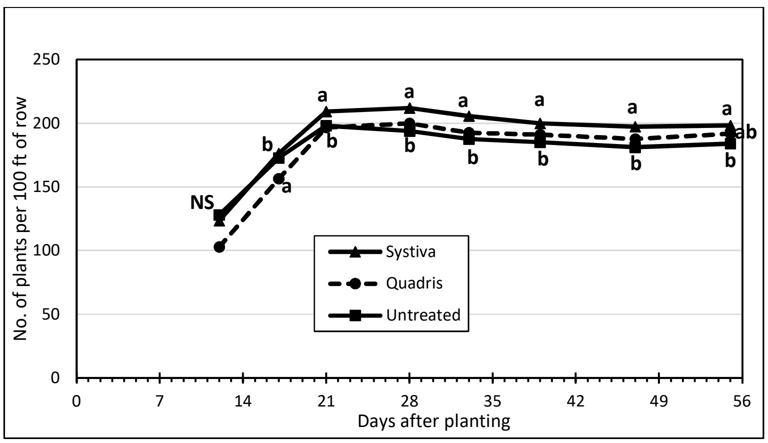

Fig. 1. NWROC site: Emergence and stand establishment for fungicide treatments at planting or untreated control. For each stand count date, values sharing the same letter are not significantly different ($P = 0.05$); NS = not significantly different. Data shown represents mean of 24 plots averaged across 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 04, 2018.

Main effect (Apron + Maxim on all seed)	No. harv. roots/100 ft[T]	RCRR (0-7)[TU]	RCRR % incidence[TV]	Yield ton A^{-1}[T]	Sucrose[T] %	lb ton^{-1}	lb A^{-1}
Variety[W]							
Resistant	159	0.3	3.3	21.0	18.1	338	7087
Moderately Susceptible	164	0.7	13.1	21.8	16.6	304	6609
ANOVA p-value	0.42	0.06	**0.02**	0.66	0.05	0.05	0.22
LSD (*P* = 0.05)	NS	NS	7.7	NS	NS	NS	NS
At-planting treatments[X]							
Untreated control	160	0.5	8.1	22.5	17.4	322	6856
Systiva @ 5 g a.i /unit	162	0.5	9.0	20.5	17.3	318	6472
Quadris In-furrow	163	0.4	7.5	21.2	17.4	324	7216
ANOVA p-value	0.74	0.67	00.76	0.27	0.92	0.81	0.18
LSD (*P* = 0.05)	NS	NS	NS	NS	NS	NS	NS
Postemergence fungicide[Y]							
None	153 b	0.9 a	16.5 a	20.4 b	17.0 b	313 b	6372 b
4-leaf Quadris @ 14.3 fl. oz./A	166 a	0.3 b	3.8 b	21.8 a	17.5 a	325 a	7068 a
8-leaf Quadris @ 14.3 fl. oz./A	165 a	0.3 b	4.4 b	21.9 a	17.5 a	325 a	7103 a
ANOVA p-value	**0.01**	**<0.0001**	**<0.0001**	**0.04**	**0.01**	**0.01**	**0.0006**
LSD (*P* = 0.05)	9	0.19	3.2	1.2	0.4	9.3	391
Vty x at-palnt	NS	NS	NS	NS	NS	NS	NS
Vty x Post	**0.04**	NS	**0.02**	NS	NS	NS	NS
At-plant x Post	NS	NS	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 36 plots (4 replicate plots across 3 at-planting treatments and 3 postemergence treatments)

[X] Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

[Y] Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 at-planting treatments)

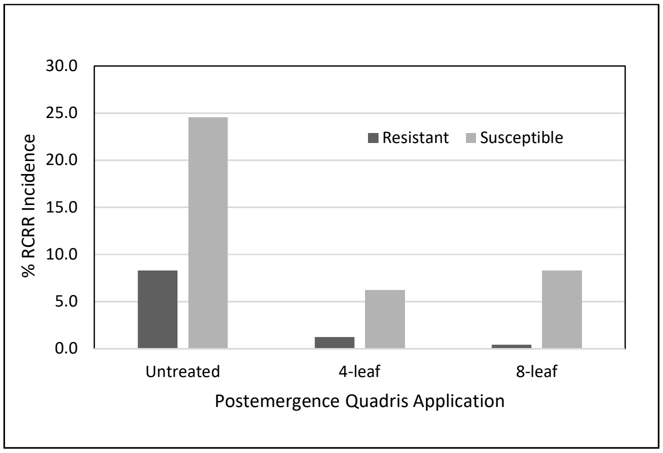

Fig. 2. NWROC site: Effect of variety and postemergence treatments on Rhizoctonia root rot incidence (percent of roots with rating greater than two).

MDFC site: Resistant and moderately resistant varieties had similar stands from 4 to 7 weeks after planting (WAP). Systiva had higher stands from 3 to 7 WAP compared to Quadris in-furrow and control treatments, which were similar, except 5 WAP where Systiva was highest, intermediate for Quadris in-furrow and lowest for control (Fig. 3). Control plants had 186 plants/100 ft. row at 7 WAP indicating very low early season disease pressure at this site. This site received good rainfall from June through September and yet disease pressure was low until harvest. There were significant variety x postemergence treatment interactions for RCRR rating, RCRR incidence and % recoverable sucrose (Table 4). Resistant variety had significantly higher percent sucrose, RST, and purity whereas moderately resistant variety had higher yield (Table 4). Quadris in-furrow had significantly lower root rot compared to Systiva and control treatments (Table 4). Postemergence application (4- or 8-leaf) significantly reduced root rot severity and incidence and 8-leaf application increased yield and RSA compared to no postemergence application (Table 4). RCRR rating and incidence was lower in the resistant variety compared to susceptible variety and hence 4- or 8-leaf Quadris application was effective on the susceptible variety to lower root rot rating and incidence (Fig. 4 A & B). This demonstrates the importance of choosing a resistant variety for managing Rhizoctonia diseases. Similar benefit from postemergence Quadris application at this location was also evident in 2016 and 2017 (4,5). Percent sucrose was higher for the resistant variety and not affected by postemergence Quadris, but was increased with postemergence Quadris applications in the susceptible variety (Fig. 4C).

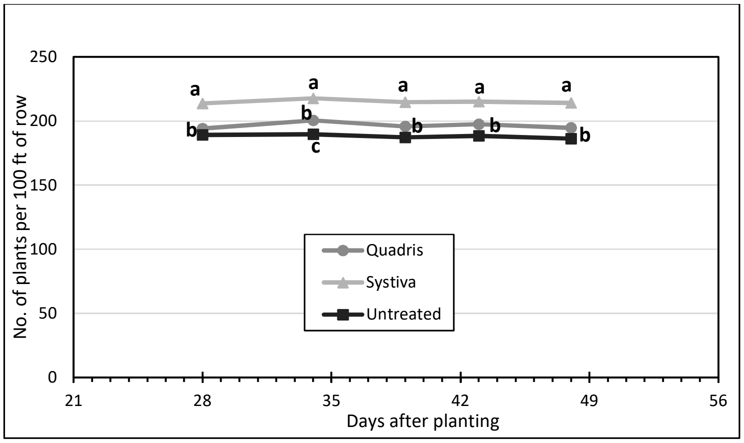

Fig. 3. MDFC site: Emergence and stand establishment for fungicide treatments at planting or untreated control. For each stand count date, values sharing the same letter are not significantly different (P = 0.05); NS = not significantly different. Data shown represents mean of 24 plots averaged across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

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 24, 2018.

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	0.1	1.8	25.9	15.1	236	6106
Moderately Susceptible	0.3	5.3	28.4	14.4	220	6247
ANOVA p-value	0.09	0.09	0.01	0.02	0.009	0.10
LSD (P = 0.05)	NS	NS	1.8	0.5	8.8	NS
At-planting treatments[X]						
Untreated control	0.2 a	4.4	27.1	14.7	226	6077
Systiva @ 5 g a.i /unit	0.2 a	4.6	27.1	14.8	230	6216
Quadris In-furrow	0.1 b	1.7	27.3	14.8	229	6236
ANOVA p-value	0.04	00.06	0.89	0.57	0.34	0.29
LSD (P = 0.05)	0.15	NS	NS	NS	NS	NS
Postemergence fungicide[Y]						
None	0.3 a	6.5 a	26.3 b	14.7	227	5953 b
4-leaf Quadris @ 14.3 fl. oz./A	0.1 b	2.5 b	27.1 b	14.7	227	6155 b
8-leaf Quadris @ 14.3 fl. oz./A	0.1 b	1.7 b	28.0 a	14.8	230	6421 a
ANOVA p-value	0.01	0.01	0.001	0.43	0.57	0.002
LSD (P = 0.05)	0.16	3.5	0.9	NS	NS	250
Vty x At-plant	NS	NS	NS	NS	NS	NS
Vty x Post	**0.02**	**0.03**	NS	**0.03**	NS	NS
At-plant x Post	NS	NS	NS	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] Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 postemergence treatments)

[Y] Values represent mean of 24 plots (4 replicate plots across 2 varieties and 3 at-planting treatments)

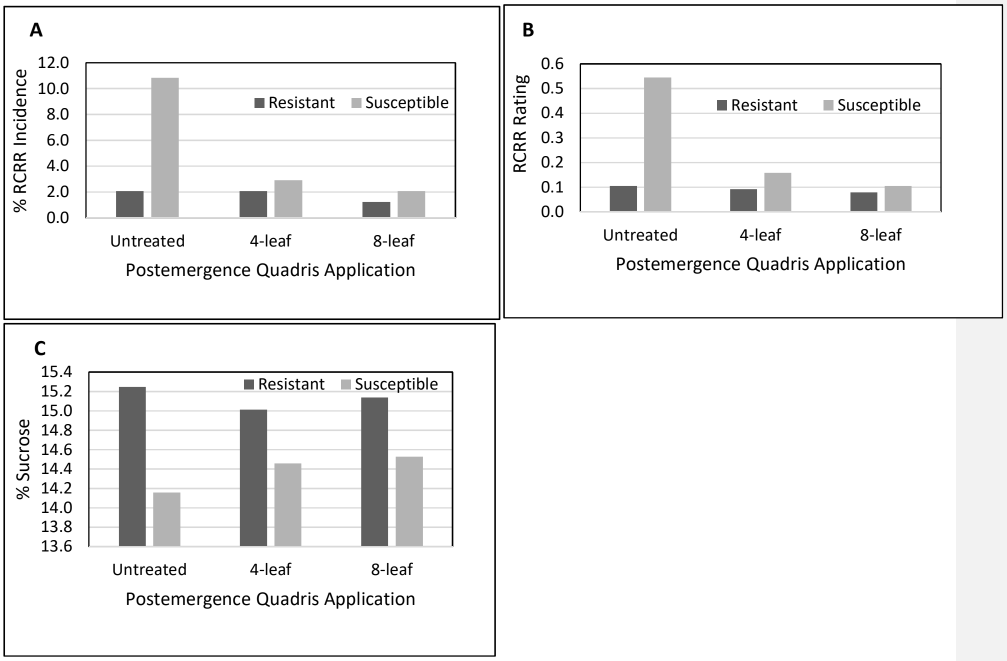

Fig. 4. MDFC site: Effect of variety and postemergence treatments on **A)** RCRR incidence and **B)** RCRR rating and **C)** percent sucrose. Rhizoctonia root rot severity (0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead). Incidence only includes percent of roots with rating greater than two.

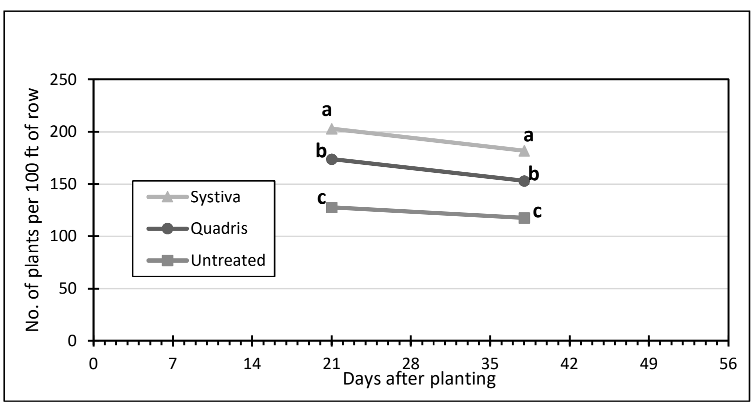

Fig. 5. SMBSC site: Emergence and stand establishment for fungicide treatments at planting or untreated control. For each stand count date, values sharing the same letter are not significantly different ($P = 0.05$); NS = not significantly different. Data shown represents mean of 24 plots averaged across varieties and postemergence treatments.

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 16, 2018.

Main effect	RCRR	RCRR %	Yield	Sucrose[T]		
(Apron + Maxim on all seed)	(0-7) [TU]	incidence[TV]	ton A^{-1}[T]	%	lb ton^{-1}	lb A^{-1}
Variety[W]						
Resistant	0.1	3.1	28.0	14.8	240	6710
Moderately Susceptible	1.6	32.4	30.4	13.2	205	6255
ANOVA p-value	0.02	0.03	0.003	0.02	0.01	0.07
LSD (*P* = 0.05)	0.9	23.5	0.5	1.0	18.0	NS
At-planting treatments[X]						
Untreated control	1.0	19.7	29.4	13.8	219	6458
Systiva @ 5 g a.i /unit	1.1	23.9	28.8	13.9	221	6326
Quadris In-Furrow	0.5	9.7	29.3	14.2	228	6663
ANOVA p-value	0.003	0.007	0.72	0.32	0.31	0.40
LSD (*P* = 0.05)	0.31	7.7	NS	NS	NS	NS
Postemergence fungicide[Y]						
None	1.2	24.7	29.0	14.1	225	6513
4-leaf Quadris @ 14.3 fl. oz./A	0.9	18.9	28.9	14.0	221	6393
8-leaf Quadris @ 14.3 fl. oz./A	0.5	9.7	29.6	13.9	222	6542
ANOVA p-value	0.0007	0.0002	0.51	0.68	0.67	0.66
LSD (*P* = 0.05)	0.32	6.4	NS	NS	NS	NS
Vty x at-plant	**0.0016**	**0.0053**	NS	NS	NS	NS
Vty x Post	**0.0213**	**0.0176**	NS	NS	NS	NS
At-plant x Post	NS	NS	NS	NS	NS	NS
Vty x at-plant x Post	**0.003**	**0.006**	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 27 plots (3 replicate plots across 3 at-planting treatments and 3 postemergence treatments)

X Values represent mean of 18 plots (3 replicate plots across 2 varieties and 3 postemergence treatments)

Y Values represent mean of 18 plots (3 replicate plots across 2 varieties and 3 at-planting treatments)

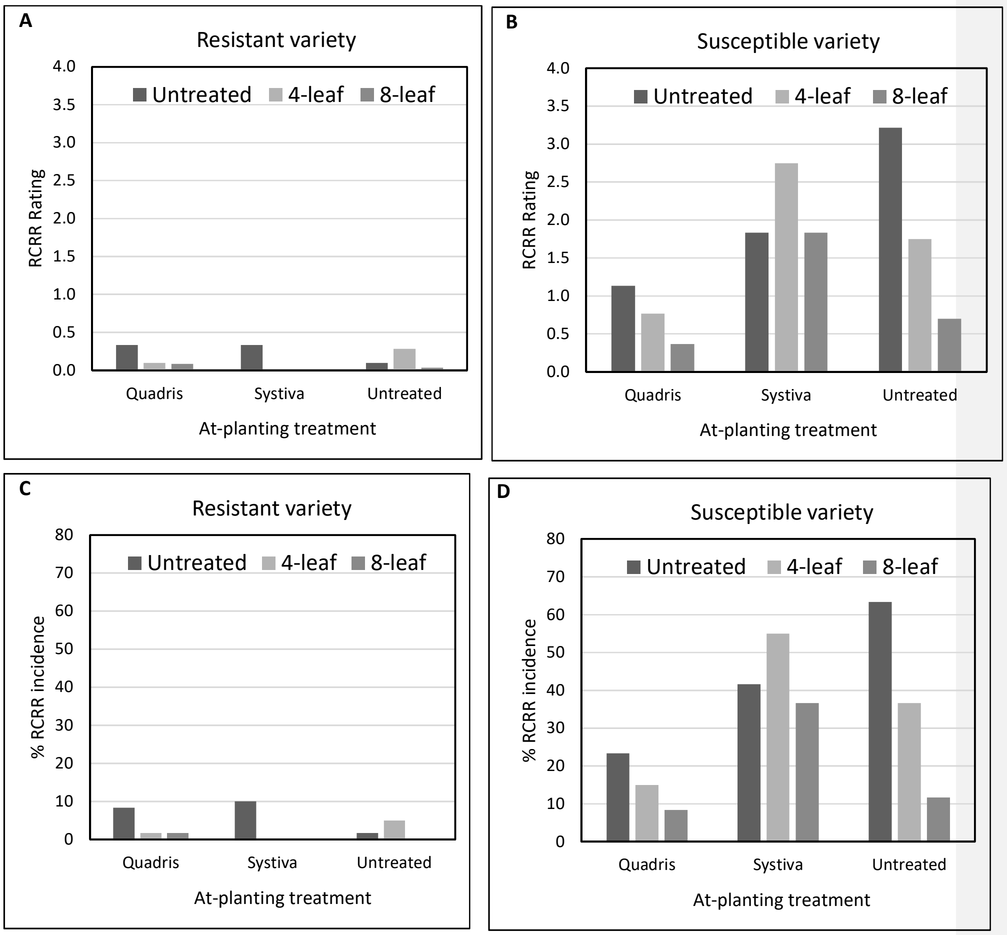

Fig. 6. SMBSC site: Effect of variety, at-planting and postemergence treatments on RCRR rating on **A)** Resistant and **B)** Susceptible variety and RCRR incidence on **C)** Resistant and **D)** Susceptible variety. Rhizoctonia root rot severity (0-7 scale (adjusted rating), 0 = root clean, no disease, 7 = root completely rotted and plant dead). Incidence only includes percent of roots with rating greater than two.

SMBSC site: This site received high rainfall and soil conditions were highly favorable for Rhizoctonia diseases immediately after planting. Resistant variety had higher stands at 3 WAP and both varieties had similar stands at 7 WAP. Systiva treatment had highest stands at 3 and 7 WAP, intermediate for Quadris in-furrow and lowest for control plots (Fig. 5). Control plants had 128 and 118 plants/100 ft. row at 3 and 7 WAP respectively, indicating very high early season disease pressure at this site (Fig. 5). Excess rainfall during the season resulted in significant stunting in one of the replications and for harvest parameters data from only 3 replications was used. There were significant variety x at-planting and variety x postemergence treatment interactions for disease severity and incidence. There was also a significant variety x at-planting x postemrgence treatment interaction for disease severity and incidence. Resistant variety had lower root rot severity and incidence and higher percent sucrose, purity, and RST than moderately resistant (Table 5). Susceptible variety had higher yield than the resistant variety, so that RSA was similar

(Table 5). Quadris in-furrow had significantly lower root rot severity and incidence compared to Systiva and control treatments (Table 5). Despite the lower number of roots in control plots at 7 WAP, final harvest parameters such as yield, RSA and RST were not significantly different between control, Systiva and Quadris in-furrow treatments (Table 5). Postemergence application (8-leaf) significantly reduced root rot severity and incidence compared to 4-leaf and no postemergence application (Table 5). RCRR rating and incidence was lower in the resistant variety compared to susceptible variety and hence 4- or 8-leaf Quadris application was effective on the susceptible variety to lower root rot rating and incidence; 8-leaf application was better compared to 4-leaf application (Fig. 6A-D). Similar benefit from postemergence Quadris application at this location was also evident in 2016 and 2017 (4,5). This clearly demonstrates the importance of choosing a resistant variety for managing Rhizoctonia diseases. In fields with heavy Rhizoctonia pressure, in-furrow application provide better protection compared to seed treatment as observed in this trial especially when using a susceptible variety for Rhizoctonia.

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EVALUATION OF AT-PLANTING FUNGICIDE TREATMENTS FOR CONTROL OF *RHIZOCTONIA SOLANI* ON SUGARBEET

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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, 4-5, 8). Disease can occur throughout the growing season and reduce plant stand, root yield, and quality. Warm and wet soil conditions favor infection. 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), and/or postemergence. An integrated management strategy should take advantage of multiple control options to reduce Rhizoctonia crown and root rot.

OBJECTIVES

A field trial was established to evaluate various at-planting fungicide treatments (seed treatment and in-furrow) for 1) control of early-season damping-off and RCRR and 2) effect on yield and quality of sugarbeet.

MATERIALS AND METHODS

The trial was established at the University of Minnesota, Northwest Research and Outreach Center (NWROC), Crookston. Field plots were fertilized for optimal yield and quality. A moderately susceptible variety (Crystal 101RR) with a 2-year average Rhizoctonia rating of 4.8 was used (9). A randomized complete block design with four replications was used. Seed treatments and rates are summarized in Table 1 and were applied by Germains Seed Technology, Fargo, ND. In-furrow fungicides (Table 1) were applied down the drip tube in 6 gallons total volume A^{-1}. The untreated control included no Rhizoctonia active seed or in-furrow fungicide treatment at planting. Prior to planting, soil was infested with *R. solani* AG 2-2-infested whole barley applied by seeding with a grain drill at 41 kg ha^{-1}. The trial was sown in six-row plots (22-inch row spacing, 25-ft rows) on May 11 at 4.5-inch seed spacing. Starter fertilizer (3 gallons A^{-1} 10-34-0) was applied in-furrow across all treatment combinations. Counter 20G (8.9 lb A^{-1}) was applied at planting and Lorsban (1 pt A^{-1}) was applied June 4 for control of sugarbeet root maggot. Sequence (glyphosate + S-metolachlor, 2.5 pt/A) was applied on May 29 and glyphosate (4.5 lb product ae/gallon) was applied on June 18 (28 oz/A), and July 9 (32 oz/A) for control of weeds. Cercospora leaf spot was controlled by Supertin + Topsin M (6 + 10 oz/A) on August 2 applied in 17 gallons water/A with 8002 flat fan nozzles at 90 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. Standard rates of Allegiance + Thiram and 45 g/unit Tachigaren were on all seed. In-furrow fungicides were applied down the drip tube in a total volume of 6 gal/A.

Application	Product	Active ingredient	Rate[Y]
None	-	-	-
Seed	Kabina ST	Penthiopyrad	14 g a.i./unit seed
Seed	Metlock Suite + Kabina ST	Metcon + Rizo + Penthio	0.21 + 0.5 + 7 g a.i./unit seed
Seed	Metlock Suite + Vibrance	Metcon + Rizo + Sedaxane	0.21 + 0.5 + 1.0 g a.i./unit seed
Seed	Systiva	Fluxapyroxad	5 g a.i./unit seed
Seed	Vibrance	Sedaxane	1.5 g a.i./unit seed
In-furrow	AZteroid	Azoxystrobin	11.9 fl oz product A^{-1}
In-furrow	Quadris	Azoxystrobin	9.5 fl oz product A^{-1}
In-furrow	Xanthion	Pyraclostrobin + Bacillus amyloliquefaciens	9.0 + 1.8 fl oz product A^{-1}
In-furrow	Elatus[Z]	Azoxystrobin + Benzovindiflupyr	9.5 oz product A^{-1}

[Y] 11.9 fl oz AZteroid and 9.5 fl oz Quadris each contain approximately 70 g azoxystrobin; 9 + 1.8 fl oz Xanthion contains 67 g pyraclostrobin + ~1.2 x 10^{12} viable spores of *Bacillus amyloliquefaciens* strain MBI 600; 9.5 oz Elatus contains 80 g azoxystrobin and 40 g benzovindiflupyr
[Z] Elatus is not currently registered for use on sugarbeet

Stand counts were done beginning 11 days after planting through 8 weeks after planting. The trial was harvested on September 24. Data were collected for number of harvested roots, 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 of > 2. Data were subjected to analysis of variance using SAS Proc GLM (SAS Institute, Cary, NC). Treatment means were separated using Fisher's protected least significant difference (LSD) test at a 0.05 level of significance. Orthogonal contrasts were used to compare seed treatment versus in-furrow fungicides and seed treatment and in-furrow fungicides versus the untreated control.

RESULTS AND DISCUSSION

Emergence in plots with Rhizoctonia seed treatment fungicides was similar to the untreated control so that by 3 weeks after planting, stands were greater than 160 plants per 100 ft of row (Fig. 1). Emergence in plots with in-furrow fungicides was reduced compared with the untreated control with just over 140 plants per 100 ft of row at 3 weeks after planting (Fig. 1). After 3 weeks, stand remained steady for plots with seed treatment or in-furrow fungicides, but declined in the untreated control plots so that stand from 5 to 8 weeks after planting was similar for the untreated control and plots treated with in-furrow fungicides and higher for plots with seed treatment fungicides (Fig. 1). It is not unusual for stand establishment to be reduced for in-furrow fungicides compared to seed treatments. Soil moisture during emergence was low with rainfall at the NWROC of 0.14 and 1.72 inches in April and May, respectively. Stand establishment at 8 weeks after planting for individual treatments is shown in Table 2. Stand was highest for plots with seed treated with Metlock Suite + Kabina 7g, Systiva, and Vibrance, lowest for the untreated control, AZteroid in-furrow, and Quadris in-furrow, and intermediate for Kabina ST, Metlock Suite + Vibrance 1g, Xanthion in-furrow, and Elatus in-furrow (Table 2).

Rainfall was high in June (7.82 inches), but low in July and August (1.47 and 1.67 inches, respectively). Soil moisture was low throughout most of July and August, resulting in low late-season Rhizoctonia disease pressure in this trial. The number of harvested roots was highest for most seed treatments and Xanthion in-furrow and lower for other in-furrow fungicides and the untreated control (Table 2). There were no significant differences among individual treatments for Rhizoctonia crown and root rot or yield and quality parameters (Table 2). Root rot ratings were low for all treatments with means ranging from 0.3 to 0.9 on the 0-7 scale (Table 2), reflecting the low disease pressure from *R. solani*. Disease incidence, reported as the percent of roots with a disease rating >2 ranged from 3 to 15% (Table 2). Root and sucrose yields were good for all treatments with root yields ranging from 30.5 to 35.2 ton A^{-1} and sucrose ranging from 16.9 to 17.7%. Contrast analysis of seed treatment versus in-furrow fungicides showed higher number of harvested roots, but also Rhizoctonia root rot ratings and incidence for seed treatment compared to in-furrow fungicides (Table 2). Lack of significant differences for root and sucrose yield in 2018 is similar to 2017 when July and August were also very dry but in contrast with typical years with higher disease pressure, where in-furrow fungicides resulted in lower root rot ratings and higher yields at harvest compared to seed treatments (6-7).

ACKNOWLEDGEMENTS

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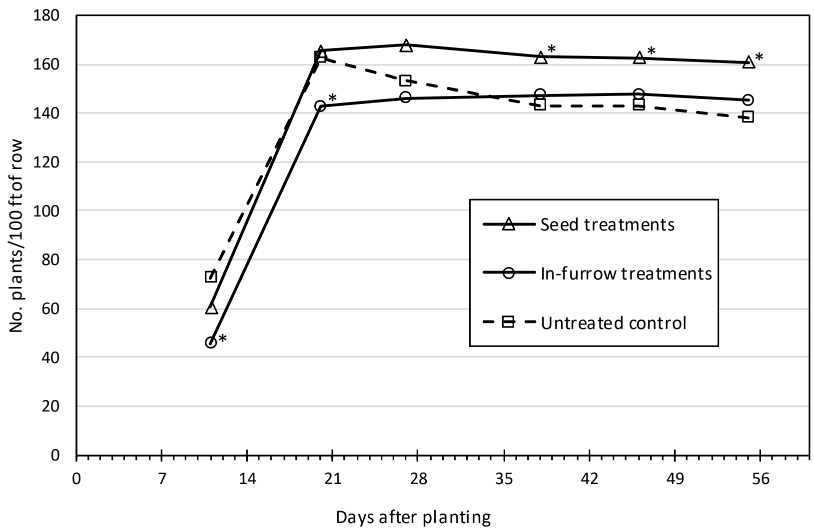

Fig. 1. Emergence and stand establishment for seed treatment and in-furrow fungicides compared to an untreated control in a sugarbeet field trial infested with *Rhizoctonia solani* AG 2-2. For each stand count date, symbols marked with an asterisk indicate stands significantly (P = 0.05) different than the untreated control (dotted line).

Table 2. Effects of at-planting (seed treatment or in-furrow) fungicide treatments on Rhizoctonia crown and root rot and sugarbeet yield and quality in a *Rhizoctonia*-infested field trial at the University of Minnesota, Northwest Research and Outreach Center, Crookston.

Treatment	8-wk stand Plants/100 ft[W]	No. harv. Roots/100 ft[W]	RCRR (0-7)[WX]	RCRR % incidence[WY]	Yield[W]	Sucrose[W] %	Sucrose[W] lb ton^{-1}	Sucrose[W] lb A^{-1}
Untreated control	138 b	136 cd	0.7	9	33.0	16.9	314	10357
Kabina ST	152 ab	144 abcd	0.9	15	34.3	17.0	311	10645
Met. Suite + 7 g Kabina	167 a	158 a	0.6	10	33.0	17.3	321	10601
Met. Suite + 1 g Vibrance	153 ab	153 ab	0.9	14	30.9	17.4	320	9944
Systiva	167 a	148 abcd	0.7	10	30.6	17.4	323	9855
Vibrance	167 a	152 abc	0.5	6	35.2	17.2	318	11153
AZteroid in-furrow	139 b	137 bcd	0.5	8	33.5	17.5	324	10850
Quadris in-furrow	138 b	132 d	0.3	4	30.5	17.7	328	9989
Xanthion in-furrow	156 ab	156 a	0.5	6	33.3	17.7	330	10969
Elatus in-furrow[Z]	149 ab	138 bcd	0.4	3	31.7	17.5	325	10303
ANOVA P-value	0.0159	0.0269	0.1840	0.5250	0.2958	0.7847	0.7872	0.5072
LSD (P = 0.05)	20.0	16.4	NS	NS	NS	NS	NS	NS
Contrast analysis								
Seed vs in-furrow								
Mean of Seed trts.	161 a	151 a	0.7 a	11 a	32.8	17.2	319	10440
Mean of In-furrow trts.	145 b	141 b	0.4 b	5 b	32.2	17.6	327	10528
P-value	0.0023	0.0122	0.0188	0.0413	0.5527	0.1418	0.1213	0.7799

[W] Values represent mean of 4 plots, NS = not significantly different
[X] RCRR = Rhizoctonia crown and root rot; 0-7 scale, 0 = root clean, no disease, 7 = root completely rotted and plant dead
[Y] RCRR = Rhizoctonia crown and root rot; percent of roots with rating > 2
[Z] Elatus is not currently registered for use on sugarbeet

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DOES *RHIZOCTONIA SOLANI* INOCULUM DENSITY INFLUENCE EFFECTIVENES OF RESISTANCE AT THE SEEDLING STAGE

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In sugar beet, *Rhizoctonia solani* Kühn not only causes Rhizoctonia crown and root rot of mature roots but can also cause damping-off in germinating seedlings (Herr, 1996). *R. solani* is endemic in growing areas across the United States and is an increasing problem world-wide. While plant breeding for Rhizoctonia disease resistance provides the most effective control to date, resistant germplasm provides protection primarily to mature beets only (Ruppel & Hecker, 1994) and most of this germplasm is not resistant at the seedling stage (Panella & Ruppel, 1996; Panella, Ruppel & Hecker, 1995). Only recently has a germplasm resistant to Rhizoctonia seedling damping-off been reported (Nagendran, Hammerschmidt & McGrath, 2009).

R. solani is a ubiquitous soilborne fungal pathogen and considered to be a species complex that contains related but genetically distinct sub-specific groups based on hyphal anastomosis reactions and pathogenicity to particular plant species. On sugar beet, *R. solani* AG 2-2 (both interspecific groups IIIB and IV) are most commonly associated with causing Rhizoctonia crown and root rot whereas *R. solani* AG-4 primarily causes Rhizoctonia seedling damping off (Hanson & McGrath, 2011; Herr, 1996; O'Sullivan & Kavanagh, 1991). However, *R. solani* AG 2-2 has been reported to be increasingly important in causing Rhizoctonia seedling damping off as well as AG 4. The relative amount of *R. solani* in the soil and how much is needed to cause disease in sugar beet is relatively unknown (Carol Windels; Frank Martin; personal communication). This is partially due to typically low inoculum densities of *R. solani* natually found in soil, and that tools are generally unable to detect such low levels of the pathogen (Paulitz & Schroder, 2005; Weinhold, 1977). Artificial inoculation of sugar beet is a common practice to elicit Rhizoctonia crown and root-rot for screening of breeding materials and germplasm for disease resistance (Pierson & Gaskill, 1961; Ruppel *et al.* 1979). However, most of these studies have not characterized what natural infection rates are necessary for creating Rhizoctonia epidemics in the field. Boosalis and Scahren (1959) have reported that they were able to recover 18X as much plant debri, that was infected with *R. solani,* from soil where Rhizoctonia disease(s) occured as compared to soils that had low incidence of disease. Likewise, Naiki and Ui (1975) reported that highest numbers of *R. solani* sclerotia can be found in soils closer to diseased beets than at increasing distances away from infected beets; and that healthy beets had the lowest numbers of sclerotia associated with them. However, neither of these studies tested what particular infection levels of *R. solani,* were required for Rhizoctonia crown and root rot development. Likewise, it has been shown that different types of inoculum preparations (i.e. sclerotia, artificial inoculum using colonized cereal grains, living mycelial fragments etc.) could influence the amount of *Rhizoctonia* diseases that can occur in soils (Chet & Baker, 1980).

We propose assays that will add *R. solani* at known inoculum densities to greenhouse soil samples (using an artificial barley inoculum) and to correlate this with the infective rate of *R. solani* required to elicit Rhizoctonia seedling damping off and Rhizoctonia crown and root rot in sugar beet.

Objectives:

Objective 1: Characterize infection rates of *R. solani* that are necessary to elicit Rhizoctonia seedling damping off and (potentially) breakdown resistance in the soil (**Completed**)

Materials and Methods

Propagule colonization with *Rhizoctonia solani*

For inoculum preparation, hydrated hulless barley grain was prepared by soaking barley with distilled water over night in mushroom bags, then autoclaved for 1h at 121˚C. The autoclaved barley grains were allowed to cool for 24h and then inoculated with a prepared liquid culture of *R. solani.* To prepare liquid inoculum, agar plugs (7 mm diameter) from each *R. solani* isolate were placed into 200mL potato dextrose broth (PDB) and shaken at 25˚C for ~5-7 days. Liquid *R. solani* inoculum was then poured over the prepared hulless barley and incubated for 14-21 days at 28˚C. Infested barley was then removed from mushroom bags and dried for 5 to 7 days at room temperature, then ground using a Wiley Mill that was sterilized between isolate treatments with 70% ethanol between each treatment. A negative (un-inoculated) control was prepared by autoclaving the hydrated hulless barley, inoculating with PDB and then drying and grinding as described above.

Soil inoculation and sugar beet pathogenicity assays to determine infective rate of *R. solani*.

Two experiments were performed. For each experiment, pasteurized potting soil (Farfard #2-SV, American Clay Works) was pre-measured and dried fully in a soil oven set at XX°C for ~5-7days. Artificial *R. solani* inoculum was prepared as described above and the number of infective particles (infection rate) of the inoculum was tested using a serial dilution plating assay as described by Webb et al. (2015) using Ko and Hora's media (Ko and Hora, 1971). After quantification of the infective rate of *R. solani* on the barley inoculum this rate was used to infect the dried sterilized soil at A) 2, 10, 20, and 200 infected particles per gram of soil (i.p./g.) and B) 0, 1, 2, and 10 i.p./g. of soil for each separate experiment respectively. Un-inoculated barley was used as a negative control for the first experiment and added at the same rates.

For each experiment, 455g of inoculated soil for each inoculum density were placed into each of four flats. Flats immediately watered by adding as much water as possible and allowing it to completely drain through then watered gently to make sure that the entire flat was completely moistened prior to seeding sugar beet. Using a pre-made template, 49 "holes" that were ~1-2cm deep were made in each flat in which 1 seed per was placed for each variety. Monogerm sugar beet varieties were used to ensure that a single seedling was produced per seed planted. For experiment A, 2 susceptible germplasm (1997A051 and 1978A045) were planted and for experiment B, 1 susceptible (1997A051) and 3 resistant germplasm (FC708CMS, FC715CMS, FC721CMS) were planted. Inoculated flats were placed into a greenhouse in a split-split plot experimental design and scored for the number of live plants germinated at 7, 10, 14, 21 days after inoculation (dai; experiment A) or 7 and 14 dai (experiment B). To determine disease severity, the % germinated plants from the number of seeds planted were calculated at each evaluation date and analyzed for significant differences using SAS statistical software.

Results and Discussion.

All inoculum studies have been completed and data analysis for significant differences in treatments are currently in progress. Preliminary findings suggest that there are difference in virulence of the two *R. solani* AG 2-2 IIIB isolates with R-9 being more virulent than R-1 but both are less virulent than the AG 4 isolate (F307). R-9 was able to cause a significant reduction in sugar beet seedlings at 2 i.p./g. of soil on both susceptible varieties whereas R-1 needed between 2-10 i.p./g. of soil. 1978A045 was more susceptible (to both isolates) than 1997A051 as it had a greater amount of seedling death as compared to the uninoculated controls. In the second experiment R-9 was able to further reduce sugar beet stands even at 1 i.p/g. soil. Some lines showed more resistance to *R. solani* infection than others with FC708 appearing to be the more resistant. However, all lines showed a significant reduction in alive seedlings when inoculated with 10 i.p./g. soil indicating that resistance is breaking down at higher inoculum loads. Statistical analysis is currently in progress.

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DEVELOPING A STRIP TILLAGE SYSTEM FOR DELIVERING FUNGICIDE FOR CONTROL OF RHIZOCTONIA SOLANI

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Rhizoctonia root and crown rot, caused by *Rhizoctonia solani* Kühn, is currently the most devastating soil borne disease of sugarbeet (*Beta vulgaris* L.) in North Dakota and Minnesota. In the bi-state area, *R. solani* anastomosis group (AG) 1, AG-2-2, AG-4 and AG-5 cause damping off and AG-2-2 causes root and crown rot of sugarbeet (Windels and Nabben 1989). *R. solani* survives as thickened hyphae and sclerotia in organic material and is endemic in soils where sugarbeet is grown. *R. solani* has a wide host range including broad leaf crops and weeds (Anderson 1982; Nelson et al. 2002). Crop rotations of three or more years with small grains planted before sugarbeet is recommended to reduce disease incidence (Windels and Lamey 1998). In fields with a history of high disease severity, growers may plant varieties that are more resistant but with significantly lower yield potential compered to more susceptible varieties (Panella and Ruppel 1996). Research showed that timely application of azoxystrobin provided effective disease control but not when applied after infection or after symptoms were observed (Brantner and Windels, 2002; Jacobsen et al. 2002).

Growers in North Dakota, Minnesota and Michigan typically use conventional land preparation for sugarbeet production. The advent of Roundup Ready sugarbeet has facilitated production using no-till or strip-till (reduced tillage) especially in areas such as Nebraska, Colorado and Montana. The objective of this research was to evaluate the effect of strip tillage and fungicide treatments with and without a post-application fungicide and their effectiveness at controlling *R. solani* and impact on yield and quality in sugarbeet.

MATERIALS AND METHODS

A field trial was conducted at Moorhead, MN in 2018. The experimental design was a randomized complete block with four replicates. Field plots comprised of six 30-foot long rows spaced 22 inches apart. Plots were planted to stand on 23 May with a susceptible variety. Seeds were treated with Tachigaren at 45 g/kg seed to provide early season protection against *Aphanomyces cochlioides*, and Poncho Beta. Counter 20G was also applied at 9 lb/A at planting to control insect pests. Weeds were controlled on 7 and 25 June. Fungicides were sprayed to control Cercorpora leaf spot on 25 July, 8 and 20 August.

The fungicides and rates used are listed in Table 1 as well as strip tillage depth. The POST band-applications were made on 21 June at the four leaf stage using 17 gal of spray solution/A while the at-strip tillage application was made on 22 May using 16 gal of spray solution/A and the in-furrow application was made at planting on 23 May using 7.1 gal of spray solution/A

Stand counts were taken during the season and at harvest. The middle two-rows of plots were harvested on 10 September and weights were recorded. Samples (12-15 roots) from each plot, not including roots on the ends of plots, were analyzed for quality at American Crystal Sugar Company tare laboratory at East Grand Forks, MN. The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 8 software package (Gylling Data Management Inc., Brookings, South Dakota, 2010). The least significant difference (LSD) test was used to compare treatments when the F-test for treatments was significant.

RESULTS AND DISCUSSIONS

There were no significant differences in plant stand from the different treatments at different dates counts were taken. However, a plant stand target of 175 to 200 plants per 100 ft of row was not attained in all treatments, probably because of inadequate moisture after planting. There was no seedling damping-off or symptoms of Rhizoctonia root rot most probably because of relatively dry conditions for most of the season. The treatment where no fungicide was applied at planting had the highest plant stand, tonnage, and recoverable sucrose. Since conditions did not favor disease development, differences in tonnage and recoverable sucrose could not be attributed to differences in timing or depth of fungicide applications. It is possible that some of the placement of the fungicides or the soil disturbance at the different depths could have adversely impact plant stands. There were significant differences in tonnage, sugar loss to molasses and recoverable sucrose among treatments, but these could not be attributed to any specific treatment or agronomic practice.

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Table 1. Strip Tillage and Rhizoctonia Control- Moorhead, MN 2018

Treatment	Timing	Stand Count 6/12	Stand Count 6/28	Stand Count 7/10	Stand Count 9/10	Yield Ton/A	Sucrose %	SLM %	Sucrose lb/a
Untreated No Kabina	-	155	167	153	165	24.6	15.5	1.50	6,882
Quadris	B	162	172	159	154	25.8	15.3	1.59	7,038
4 Inch Injection Quadris	A	167	168	163	176	26.9	15.3	1.54	7,418
0 inch depth Quadris	A	157	175	162	161	24.8	15.8	1.46	7,138
2 inch depth Quadris	A	158	168	159	155	25.0	15.5	1.66	6,900
2 and 4 inch depth Quadris	A	156	174	149	157	23.9	15.4	1.62	6,589
2 and 0 inch depth Quadris	A	153	159	154	158	24.3	15.4	1.57	6,718
No Kabina Quadris	C	194	185	191	194	28.5	15.4	1.54	7,875
Quadris	BC	164	169	167	166	24.9	15.3	1.62	6,811
4 Inch Injection Quadris	AC	175	170	168	162	24.3	15.5	1.58	6,773
0 inch depth Quadris	AC	174	180	172	158	26.1	15.5	1.50	7,299
2 inch depth Quadris	AC	170	192	171	162	25.1	15.2	1.68	6,781
2 and 4 inch depth Quadris	AC	172	182	172	168	27.0	15.2	1.58	7,343
2 and 0 inch depth Quadris	AC	157	164	159	163	25.3	15.3	1.66	6,896
LSD P=0.10	-	NS	NS	NS	NS	1.85	NS	0.105	558.6

Stand Counts are #/100' Row
Harvest occurred at time of last stand count; 10 September, 2018
Application A was injected during strip tillage on 22 May, 2018
Application B was applied In-Furrow during planting on 23 May, 2018
Application C was applied at the 4-6 leaf stage on 21 June, 2018

EFFICACY OF FUNGICIDES FOR CONTROLLING CERCOSPORA LEAF SPOT ON SUGARBEET

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Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola* Sacc., is the most economically damaging foliar disease of sugarbeet in Minnesota and North Dakota. The disease reduces root yield and sucrose concentration and increases impurity concentrations resulting in reduced extractable sucrose and higher processing losses (Smith and Ruppel, 1973; Khan and Smith, 2005). Roots of diseased plants do not store well in storage piles that are processed in a 7 to 9 month period in North Dakota and Minnesota (Smith and Ruppel, 1973). Cercospora leaf spot is managed by integrating the use of tolerant varieties, reducing inoculum by crop rotation and tillage, and fungicide applications (Khan et al; 2007). It is difficult to combine high levels of Cercospora leaf spot resistance with high recoverable sucrose in sugarbeet (Smith and Campbell, 1996). Consequently, commercial varieties generally have only moderate levels of resistance and require fungicide applications to obtain acceptable levels of protection against Cercospora leaf spot (Miller et al., 1994) under moderate and high disease severity.

The objective of this research was to evaluate the efficacy of fungicides used in rotation to control Cercospora leaf spot on sugarbeet.

MATERIALS AND METHODS

A field trial was conducted at Foxhome, MN in 2018. The experimental design was a randomized complete block with four replicates. Field plots comprised of six 30-feet long rows spaced 22 inches apart. Plots were planted on 12 May with a variety susceptible to Cercospora Leaf Spot. Seeds were treated with Tachigaren (45 g/kg seed), Vibrance and Cruiser Maxx. Seed spacing within the row was 4.7 inches. Weeds were controlled with herbicide applications (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Savvy 1 pt; Interlock @ 4 fl oz per acre) on 8 June and (Roundup Powermax @ 32 fl oz; Outlook @ 12 fl oz; Npak @2.5% v/v; Interlock @ 4 fl oz per acre) 26 June. Quadris (14.3 fl oz per acre) was applied on 25 May and 19 June to control *Rhizoctonia solani*. Plots were inoculated on 28 June with *C. beticola* inoculum.

Fungicide spray treatments were applied with a CO_2 pressurized 4-nozzle boom sprayer with 11002 TT TwinJet nozzles calibrated to deliver 17 gpa of solution at 60 p.s.i pressure to the middle four rows of plots. Most fungicide treatments were initiated on 18 July. Most treatments included four fungicide applications on 18 July, 31 July, 16 August and 31 August. One treatment received applications on a shorter interval and had application dates of 19 July, 27 July, 6 August, 16 August and 31 August. Treatments were applied at rates indicated in Table 1.

Cercospora leaf spot severity was rated on the leaf spot assessment scale of 1 to 10 (Jones and Windels, 1991). A rating of 1 indicated the presence of 1- 5 spots/leaf or 0.1% disease severity and a rating of 10 indicated 50% or higher disease severity. Cercospora leaf spot severity was assessed five times during the season. The rating performed on 16 September is reported.

Plots were defoliated mechanically and harvested using a mechanical harvester on 1 October. The middle two rows of each plot were harvested and weighed for root yield. Twelve to 15 representative roots from each plot, not including roots on the ends of the plot, were analyzed for quality at the American Crystal Sugar Company Quality Tare Laboratory, Moorhead, MN. The data analysis was performed with the ANOVA procedure of the Agriculture Research Manager, version 8 software package (Gylling Data Management Inc., Brookings, South Dakota, 2010). The least significant difference (LSD) test was used to compare treatments when the F-test for treatments was significant.

RESULTS AND DISCUSSIONS

Environmental conditions were not favorable for rapid development of *C. beticola* after inoculation on 29 June and first symptoms at very low incidence were observed in mid-July when fungicide application started. On 9 August, CLS rating for the non-treated check was 3.5, still below the CLS rating (6.0) at which economic losses typically occur. Wet and warmer conditions in started in mid-August resulting in favorable conditions for rapid disease development as indicated by a CLS rating of 9.5 for the non-treated check by 14 August, followed by loss of mature leaves and re-growth of new leaves in mid-September.

The CLS population, which originated from growers' fields near Foxhome, MN, was resistant to QoI fungicides and had the G143A mutation. The use of fungicide mixtures in a rotation program applied at 10 to 12 day and at 14 day intervals effectively controlled CLS. The non-treated check had significantly higher CLS ratings compared to the fungicide treatments (Table 1). The fungicide treatments resulted in significantly higher sugar concentration and recoverable sucrose per ton of sugarbeet compared to the non-treated check.

This research indicated that fungicides should be applied starting promptly at first symptoms of CLS and continued during the season once environmental conditions are favorable for disease development since our fields have a high pathogen population. Each application should comprise of at least two modes of action, and when necessary such as during periods of regular rainfall, spray interval should be reduced from 14 to 12 or 10 days. In this trial, fungicide application was discontinued in early September to facilitate harvesting in mid- to late-September.

General comments for Cercospora leaf spot control in growers' fields in North Dakota and Minnesota where inoculum levels will probably be high in 2019 and CLS tolerant (KWS ratings of 5.2 and less) varieties are grown:

1. The first fungicide application should be made when disease symptoms are first observed (which entails scouting after row closure) or soon after row closure. If the first application is late, control will be difficult all season.
2. Since the pathogen population is very high, especially from the central Red River Valley going south, fungicide applications should be made at regular intervals (14 or 10 to 12 during periods with more rainfall).
3. Use mixtures of fungicides that are effective at controlling Cercospora leaf spot in an alternation program.
4. Use the recommended rates of fungicides to control Cercospora leaf spot.
5. During periods of regular rainfall, shorten application interval from 14 days to 12 or 10 days; use aerial applicators during periods when wet field conditions prevent the use of ground rigs.
6. Limit or avoid using fungicides to which the pathogen population has become resistant or less sensitive.
7. Only one application of a benzimidazole fungicide (such as Topsin M 4.5F) in combination with a protectant fungicide (such as SuperTin). The use of multi-site fungicides such as TPTH, Copper, and EBDCs mixed with a QoI or DMI fungicides will increase the effectiveness of the QoIs and DMIs.
8. Avoid using fungicides in an area where laboratory testing shows that the fungus has developed resistance or reduced sensitivity to that particular fungicide or particular mode of action.
9. Use high volumes of water (15 to 20 gpa for ground-rigs and 3 to 5 gpa for aerial application) with fungicides for effective disease control.
10. Based on the 2018 *C. beticola* population and sensitivity testing, CLS spray applications should start early at first symptoms, or at disease onset just after row closure.

The following fungicides in several classes of chemistry are registered for use in sugarbeet:

Strobilurins	**Sterol Inhibitors**	**Ethylenebisdithiocarbamate (EBDC)**
Headline/Pyrac	Eminent/Minerva	Penncozeb
Gem	Inspire XT	Manzate
Quadris	Proline	Mancozeb
(Priaxor)	Minerva Duo	Maneb
	Enable	(Mankocide)
	Topguard	

Benzimidazole	**TriphenylTin Hydroxide (TPTH)**	**Copper**
Topsin	SuperTin	Kocide
	AgriTin	Badge
		Champion
		(Mankocide)

Products within ( ) indicate that they comprise of more than one mode of action.

Table 1. Effect of fungicides on Cercospora leaf spot control and sugarbeet yield and quality at Foxhome, MN in 2018.

Treatment and rate/A	CLS*	Root yield	Sucrose concentration	Recoverable sucrose		Returns**
	1-10	Ton/A	%	lb/Ton	lb/A	$/A
Minerva Duo 16 fl oz/ Topsin 10 fl oz + Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125% v/v + Manzate Max 1.6 qt/ Mankocide 4.3 lb	3.3	35.45	17.10	319	11,255	1,320
Topsin 10 fl oz + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Minerva Duo 16 fl oz + Badge SC 2 pt	3.5	32.20	17.47	327	10,843	1,310
Super Tin 8 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 4 pt/ Mankocide 4.3 lb	3.0	35.60	16.83	313	11,140	1,270
Super Tin 8 fl oz + Manzate Max 1.6 qt + Topsin 10 fl oz/ Inspire XT 7 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb/ Super Tin 8 fl oz + Badge SC 2 pt	3.8	35.00	16.79	310	10,855	1,228
Topsin 10 fl oz + Super Tin 8 fl oz/ Minerva Duo 16 fl oz/ Mankocide 4.3 lb/ Proline 5 fl oz + NIS 0.125 % v/v/ Badge SC 2 pt	3.0	35.25	16.57	308	10,889	1,226
Topsin 10 fl oz + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Mankocide 4.3 lb/ Minerva Duo 16 fl oz	3.5	35.13	16.43	307	10,757	1,197
Inspire XT 7 fl oz + Super Tin 8 fl oz/ Topsin 10 fl oz + Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125 % v/v + Manzate Max 1.6 qt/ Mankocide 4.3 lb	3.3	32.70	16.98	316	10,302	1,182
Inspire XT 5.3 fl oz + Topsin 7.6 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 Qt/ Proline 3.8 fl oz + NIS 0.125 % v/v + Manzate Max 1.2 qt***	4.0	33.88	16.20	305	10,317	1,140
Minerva Duo 16 fl oz/ Topsin 10 fl oz + Super Tin 8 fl oz/ Proline 5 fl oz + NIS 0.125 % v/v + Badge SC 2 pt/ Mankocide 4.3 lb	3.8	36.90	16.00	292	10,774	1,111
Inspire XT 7 fl oz + Topsin 10 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt	4.8	34.30	16.19	298	10,180	1,091
Topsin 10 fl oz + Super Tin 8 fl oz/ Inspire XT 7 fl oz + Manzate Max 1.6 qt/ Priaxor 8 fl oz + Badge SC 2 pt/ Super Tin 8 fl oz + Badge SC 2 pt	4.8	32.56	16.45	305	9,884	1,082
ET-F 19.2 fl oz + Inspire XT 7 fl oz + Topsin 10 fl oz + Antero EA 16 fl oz/100 gal/ ET-F 19.2 fl oz + Antero EA 16 fl oz/100 gal + Super Tin 8 fl oz/ ET-F 19.2 fl oz + Anteroa EA 16 fl oz/100gal + Proline 5 fl oz/ ET-F 19.2 fl oz +Antero EA 16 fl oz/100gal + Super Tin 8 fl oz	4.5	31.85	16.28	303	9,647	1,061
Inspire XT 5.3 fl oz + Topsin 7.6 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 qt/ Minerva Duo 16 fl oz/ Super Tin 6 fl oz + Manzate Max 1.2 Qt	4.5	29.53	16.53	308	9,056	1,029
Minerva Duo 16 fl oz/ Super Tin 8 fl oz + Manzate Max 1.6 qt/ Priaxor 8 fl oz + Badge SC 2 pt/ Mankocide 4.3 lb	4.0	34.68	15.83	290	10,043	994
Untreated Check	9.8	29.75	14.23	262	7,891	761
LSD (P=0.10)	**0.76**	**3.08**	**1.17**	**25**	**1,175**	**248**

*Cercospora leaf spot measured on 1-10 scale (1 = 1- 5 spots/leaf or 0.1% severity and 10 = 50% severity) on 14 September.
**Returns based on American Crystal payment system and subtracting fungicide costs and application.
***Treatment applied on 10-12 day interval.

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SENSITIVITY OF *CERCOSPORA BETICOLA* TO FOLIAR FUNGICIDES IN 2018

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Leaf spot, caused by the fungus *Cercospora beticola*, is an endemic disease of sugarbeet produced in the Northern Great Plains area of North Dakota and Minnesota that reduces both yield and sucrose content. The disease is controlled by crop rotation, resistant varieties and timely fungicide applications. *Cercospora* leaf spot usually appears in the last half of the growing season, and multiple fungicide applications are necessary for disease management. Fungicides are used at high label rates and are alternated for best efficacy, but in recent years, mixtures are becoming more important. The most frequently used fungicides are Tin (fentin hydroxide), Topsin (thiophanate methyl), Eminent (tetraconazole), Proline (prothioconazole), Inspire (difenoconazole) and Headline (pyraclostrobin). In 2018, most of the DMI and QoI fungicides were applied as mixtures with either mancozeb or copper and Topsin is usually applied as a tank mix with Tin.

Like many other fungi, *C. beticola* has the ability to become less sensitive (resistant) to the fungicides used to control them after repeated exposure, and increased disease losses can result. Because both *C. beticola* and the fungicides used for management have histories of fungicide resistance in our production areas and other production areas in the US, Europe and Chile, it is important to monitor our *C. beticola* population for changes in sensitivity to the fungicides in order to achieve maximum disease control. We have monitored fungicide sensitivity of field isolates of *C. beticola* collected from fields representing the sugarbeet production area of the Red River Valley region to the commonly used fungicides in our area annually since 2003. In 2018, extensive sensitivity monitoring was conducted for Tin, Topsin, Eminent, Inspire, Proline and Headline.

OBJECTIVES

1) Monitor sensitivity of *Cercospora beticola* isolates to Tin (fentin hydroxide)

2) Monitor sensitivity of *Cercospora beticola* isolates to Topsin (thiophanate methyl)

3) Monitor sensitivity of *Cercospora beticola* to three triazole (DMI) fungicides: Eminent (tetraconazole) and Inspire (difenoconazole) and Proline (prothioconazole)

4) Monitor *Cercospora beticola* isolates for the presence of the G143A mutation that confers resistance to Headline (pyraclostrobin) fungicide

5) Distribute results of sensitivity monitoring in a timely manner to the sugarbeet industry in order to make fungicide recommendations for disease management and fungicide resistance management for Cercospora leaf spot disease in our region.

METHODS AND MATERIALS

In 2018, with financial support of the Sugarbeet Research and Extension Board of MN and ND, we tested 1097 *C. beticola* field isolates collected from throughout the sugarbeet production regions of ND and MN for sensitivity testing to Tin, Topsin, Eminent, Inspire, Proline and Headline. For this report we use the commercial name of the fungicides, but all testing was conducted using the technical grade active ingredient of each fungicide, not the formulated commercial fungicide. The term µg/ml is equivalent to ppm.

Sugarbeet leaves with Cercospora leaf spot (CLS) are collected from commercial sugarbeet fields by agronomists from American Crystal Sugar Company, Minn-Dak Farmers Cooperative and Southern Minnesota Beet Sugar Cooperative representing all production areas in ND and MN and delivered to our lab for processing. From each field sample, *C. beticola* spores were collected from a minimum of five spots per leaf from five leaves and mixed to make a composite of approximately 2500 spores.

For Tin testing, a subsample of the spore composite was transferred to a Petri plate containing water agar amended with Tin at 1 ug/ml. Germination of 100 spores on the Tin amended water agar plates were counted 16 hours later and percent germination calculated. Germinated spores are considered resistant.

For Topsin testing, a PCR based molecular procedure was used to test for the presence of a specific mutation in *C. beticola* that imparts resistance to Topsin. This is the first year the PCR test was used for testing for Topsin resistance and replaces the spore germination test.

For triazole fungicide sensitivity testing, a radial growth procedure is used. A single spore subculture from the spore composite is grown on water agar medium amended with serial ten-fold dilutions of each technical grade triazole fungicide from 0.01 – 10.0 ppm. A separate test is conducted for each triazole fungicide. After 15 days, inhibition of radial growth is measured, and compared to the growth of *C. beticola* on non-amended water agar medium. This data is used to calculate an EC_{50} value for each isolate; EC_{50} is a standardized method of measuring fungicide resistance and is calculated by comparing the concentration of fungicide that reduces radial growth of *C. beticola* by 50% compared to the growth on non-amended media. Higher EC_{50} values mean reduced sensitivity to the fungicide. An RF (resistance factor) is calculated for each triazole fungicide by dividing the EC_{50} value by the baseline value so fungicides can be directly compared.

For Headline resistance testing a PCR based molecular procedure was used to test for the presence of a specific mutation in *C. beticola* that imparts resistance to Headline. This procedure detects a specific mutation, G143A, which results in complete resistance to Headline. DNA is extracted from the remaining spore composite and tested by real-time PCR using primers specific for the G143A mutation. The test enables us to estimate the percentage of spores with the G143A mutation in each sample. Each sample tested contains approximately 2500-5000 spores and the DNA from this spore pool will test for the G143A mutation from each spore. The PCR test is more sensitive and requires less interpretation than the previously used spore germination test. The PCR test will estimate the incidence of resistance in the population of spores tested, and give a better indication of Headline resistance in a field.

RESULTS AND DISCUSSION

CLS pressure was moderate in most locations in 2018, but disease pressure was higher in the southern growing areas due to continuing and heavy rains producing conditions ideal for *C. beticola* infection. CLS control was generally good until the end of the season, but the amount of disease was variable. The majority of the CLS samples were delivered to our lab at the end of the season in late September and early October. All arrived as fresh samples in excellent condition with the exception of a few wet samples that rotted and could not be tested. Field samples (n=1097) representing all production areas and factory districts were tested for sensitivity to six fungicides: fentin hydroxide (Tin), thiophanate methyl (Topsin), tetraconazole (Eminent), difenoconazole (the most active part of Inspire), prothioconazole (Proline) and pyraclostrobin (Headline). One additional DMI fungicide not registered in the US for CLS were tested for activity against *C. beticola*.

TIN. Tolerance (resistance) to Tin was first reported in 1994 at concentrations of 1-2 µg/ml. At these levels, disease control in the field is reduced. The incidence of fields with isolates resistant to Tin at 1.0 µg/ml increased between 1997 and 1999, but the incidence of fields with resistant isolates has been declining since the introduction of additional fungicides for resistance management, including Eminent in 1999, Gem in 2002 and Headline in 2003. In 1998, the incidence of fields with isolates resistant to Tin at 1.0 µg/ml was 64.6%, and declined to less than 10% from 2002 to 2010. From 2011 to 2014 there was an increase in the number of fields with resistance **(Figure 1),** and from 2015 to 2017, the incidence of fields with isolates resistant to Tin increased from 38.5% to 97% (**Figure 1**). In 2018, the incidence of fields with isolates resistant to tin declined to 65.2% (**Figure** 1). The severity of resistance, as expressed as percent germination of spores from fields with resistant isolates, ranged from 1 to 100%, with the average germination rate ranging from 16 to 28% during the five year period of 2013 to 2017 **(Figure 1)**. In 2018, the severity of resistance declined to 15.5%. The incidence of fields with tin resistance declined dramatically in all factory districts (**Figure. 2**). The low severity of resistance (~15%) may be the reason that tin is still an effective fungicide for managing CLS despite widespread incidence of resistance to tin.

TOPSIN. Resistance to Topsin has been present in our area since 1999, and is also common and widespread in European Union production areas. Resistance has historically been >70% but has declined below that level in six of the past twelve years. Topsin resistance, in sugarbeet and other crops, tends to decline when it is not used, but reappears quickly when it is again used in the field. Since 2013, the incidence of field with Topsin resistance was >70% (**Figure** 3). The incidence of fields with Topsin resistance in 2018 increased to 88.6% (**Figure 3**). The severity of resistance, as expressed as percent germination of spores from fields with resistant isolates ranged from 1 to 100%, with the average germination rate of 25% in 2017. We were not able to test severity of resistance in 2018 using the PCR test. Most applications of Topsin are as tank mixtures with Tin, which seems to be an effective management practice.

DMI (triazoles). Sensitivity of *C. beticola* isolates to the DMI fungicides Eminent and Inspire, as measured by the Resistance Factor (RF) values, doubled from 2007 to 2009 (**Figure 4**), with average RF values <3.0 (RF values are the EC_{50} values divided by the baseline values). From 2011 to 2014, RF values of both Eminent and Inspire increased 28 and 32 fold above the baseline (data not shown). Surprisingly, in 2015 there was a 29% and 69% decline to in RF values to Eminent and Inspire respectively across all factory districts to average RF values of 39.0 and 21.0 (data not shown). In 2016, the RF value of Eminent declined slightly and increased slightly for Inspire across all factory districts (data not shown). In 2017, RF values for both Eminent and Inspire increased **(Figure 4)**, ranging from 27.1 in the Moorhead district to 57.0 in the Hillsboro district (data not shown). In 2018, the RF values for both Eminent and Inspire increased to 59.9 and 41.1 respectively **(Figure 4).** The RF values across factory districts ranged from 51.8 to 77.48 for Eminent, and from 32.09 to 72.89 for Inspire **(Figure 5).**

The RF values of *C. beticola* isolates to Proline from 2016 to 2017 were 6.5 and 9.1 respectively, and in 2018 was 10. These values are much lower than either Eminent or Inspire RF values. This was observed in every factory district **(Figure 5).** Proline has been more frequently used in recent for managing CLS, and provides a good triazole based fungicide for use. We are conducting additional work to understand more about fungicide resistance testing for Proline.

The resistance to the triazole fungicides we see in US isolates of *C. beticola* is related to overexpression of Cyp51 enzyme, and not due to a specific genetic mutation, so it will be difficult to develop a PCR assay for this group of fungicides. In companion studies we have conducted, higher levels of resistance to triazole fungicides are present in *C. beticola* isolates collected from Italy and France than found in the RRV production area. This year we tested 50 highly resistant isolates up to 100 µg/ml to see how high EC_{50} values are >10. Of these isolates, the average EC_{50} was 44.04 µg/ml, with a range from11.13 µg/ml to 78.76 µg/ml. These values are similar to EC_{50} values documented in sugar beet fields in the EU with high levels of resistance where DMI fungicides are no longer effective. Obviously, this is a concern for our industry.

HEADLINE. Based on EC_{50} values using spore germination testing, sensitivity of C. *beticola* to Headline remained relatively stable from 2003-2009 with only a seven-fold decrease in sensitivity. Beginning in 2012, a PCR based molecular procedure was used to test for the presence of the G143A mutation in *C. beticola* using the remainder of the composite spore sample containing approximately 2500-5000 spores. The presence of this mutation indicates absolute resistance to Headline. The results are placed in five categories based on an estimate of the percentage of spores with the G143A mutation: S = no spores with G143A; S/r = <50 of the spores with G143A; S/R = equal number of spores with G143A; R/s >50% of the spores with G143A; and R = all spores with G143A**.** The G143A mutation was first detected in the RRV production area in 2012 and increased from 2013 to 2015. Resistance to Headline in 2016 increased dramatically with a commensurate loss in sensitivity Across all factory districts in 2016 and 2017, ~10% of the isolates collected had all spores without the G143A mutation; the G143A mutation was found in 90% of the samples, and 49.7% of the samples has >50 of the spores with the G143A mutation (**Figure 6**). Results from 2018 testing are similar; 13.7% of the samples tested contained all spore without the G143A mutation **Figure 6).** Samples with an R rating (all spores resistant) were found in all factory districts ranging 27.0 % (Minn-Dak) to 80.5% (Hillsboro). (**Figure 7**). Samples with S (all spores sensitive) ranged from 0% (Hillsboro) to 9.5% (Drayton) **(Figure 7)**. Based on this data, the QoI fungicides Headline and Gem will likely not control CLS and again will not be widely used in 2018. Although this is a stable mutation, we will continue to partially monitor for resistance to Headline in the RRV production area, particularly because Headline is often the only fungicide used, and is used annually even in the absence of disease. We do not know if there is a fitness penalty associated with the G143A mutation, but based on observation in MI and Italy, Austria and Serbia, where QoI resistance due to the G143A mutation is widespread. it appears that isolates with the G143A mutation are stable and can survive and increase in the population.

An increasing concern is the development of *C. beticola* isolates with resistance (reduced sensitivity) to more than one fungicide. In 2018, 11.0% of the isolates were resistant to all four fungicide classes.

	2013	2014	2015	2016	2017	2018
Eminent > 1 µg/ml	60.4	78.9	49.3	41,3	25.9	82.2
Inspire > 1 µg/ml	26.6	46.8	28.9	31.8	47.1	55.9
Tin > 1 µg/ml	14.8	12.5	38.5	46.0	97.0	37.6
Headline	14.2	30.8	61.1	91.3	92.6	95.0
Eminent & Inspire > 1 µg/ml	26.0	41.0	21.1	24.4	30.6	53.3
Eminent, Inspire & Tin	5.2	4.2	13.6	19.7	27.7	21.2
Eminent, Inspire, Tin and Headline	0.5	1.6	4.9	14.4	14.0	11.0

SUMMARY

1. Resistance to Tin at 1.0 µg/ml almost disappeared in our region from 2003-2010, but has increased since 2011, probably due to increased use. In 2016, isolates from 46% of the fields samples had some resistance to tin, with a median germination rate of 26%. In 2018, both incidence and severity of Tin resistance declined, but continued to be found in all factory districts.

2. Resistance to Topsin at 5.0 µg/ml continues to be present in our region at high levels. In 2018, isolates from 88.6% of the field samples had some resistance to Topsin. PCR testing was used for Topsin testing for the first time in 2018. Topsin resistance was found in all factory districts.

3. Resistance to both Eminent and Inspire, as measured by RF values, increased in 2018 in all factory districts. Proline had much lower resistance values than Eminent or Inspire.

4. The number of isolates with the G143A mutation that results in resistance to Headline was similar in 201 to previous years. There were differences among factory districts for resistance, but not sensitivity. Approximately 90% of the fields sampled have some level of resistance to Headline, and approximately 50% of the fields sampled have >50% of the spores resistant to Headline. These findings may preclude the effective use of Headline for CLS management in 2018.

5. The incidence of *C. beticola* isolates with resistance to multiple fungicides is a concern. In 2018, 11.0ut 14% of the isolates tested have resistance to all four classes of fungicides used.

6. We recommend continuing disease control recommendations currently in place including fungicide rotation, using high label rate of fungicides, mixtures with mancozeb or copper, scouting at end of the season to decide the necessity of a late application, using fungicide resistance maps for fungicide selection, using a resistant variety, spray intervals of 14 days, and applying fungicides to insure maximum coverage. It appears that early fungicide applications in 2018 helped manage CLS and early applications should continue in 2019. Improved disease control may be possible with improvements in fungicide coverage using proper spray nozzles and spray parameters such as timing, rat, interval and coverage.

Figure 1. Incidence and severity of tin resistance in *C. beticola* isolates collected from sugar beet fields in ND and MN from 2003 to 2018

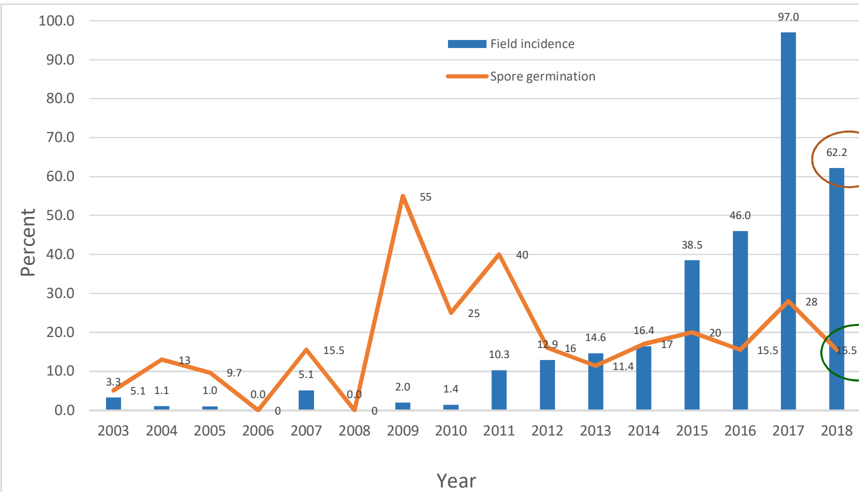


Figure 2. Incidence of fields with *C. beticola* isolates collected in ND and MN resistant to tin from 2013 to 2018 by factory district

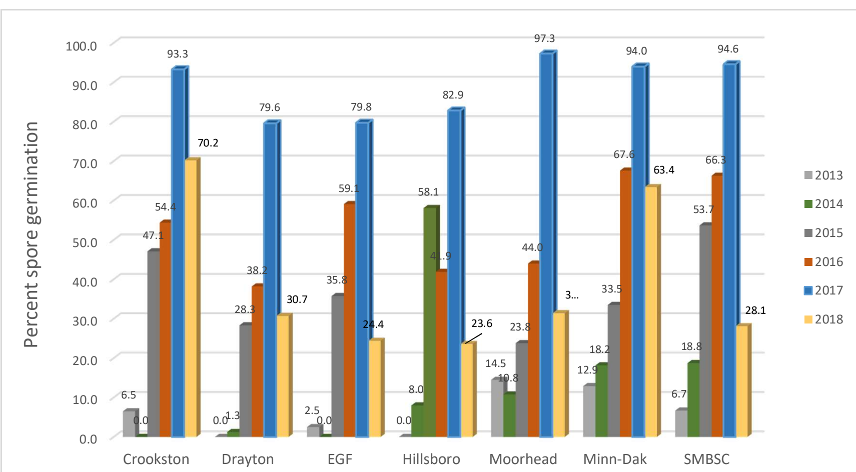


Figure 3. Percent of *Cercospora beticola* field isolates collected in ND and MN from 1999 to 2018 with growth on medium amended with Topsin at 5 µg/ml

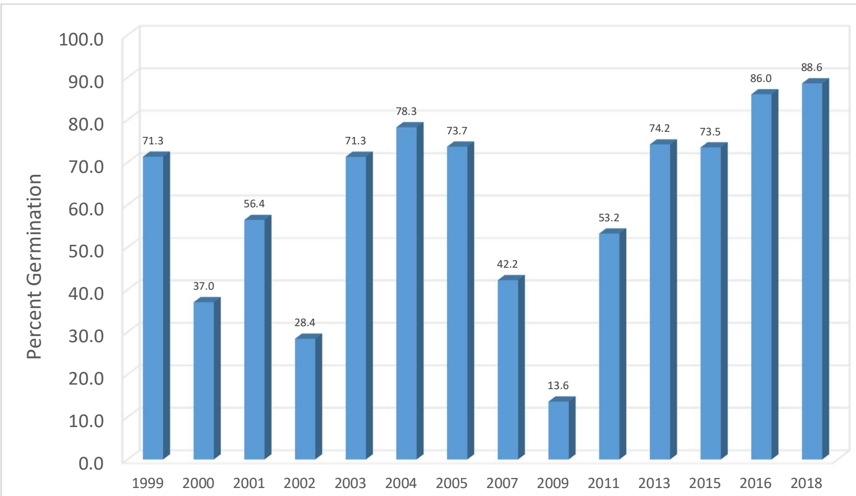


Figure 4. Resistance Factor of *C. beticola* isolates collected in ND and MN from 2007-2018 to Eminent, Inspire and Proline

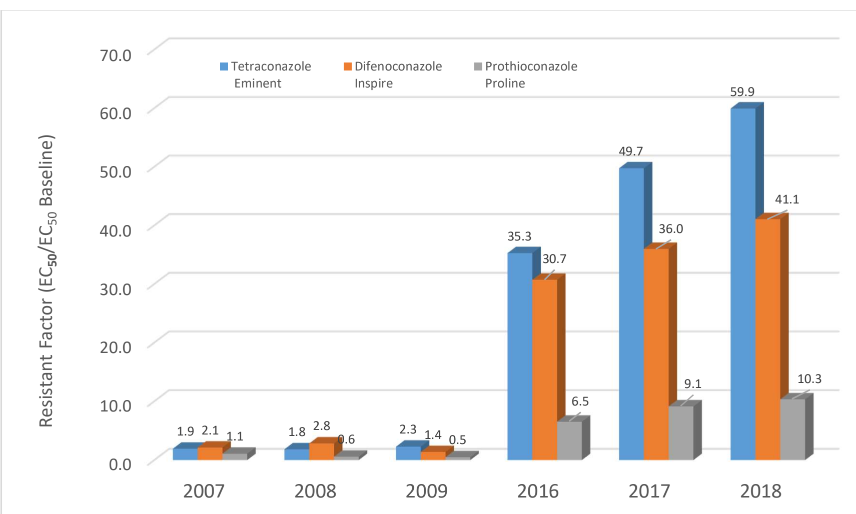


Figure 5. Sensitivity of *C. beticola* isolates collected in 2018 to Eminent, Inspire and Proline by factory district as expressed by RF values

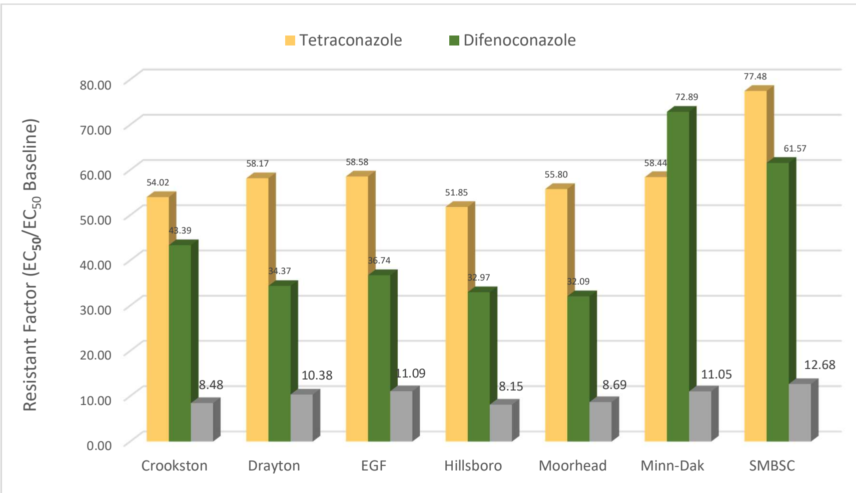


Figure 6. Sensitivity of *C. beticola* isolates collected in ND and MN to Headline from 2012 to 2018 as expressed by the percentage of spores with G143A mutation

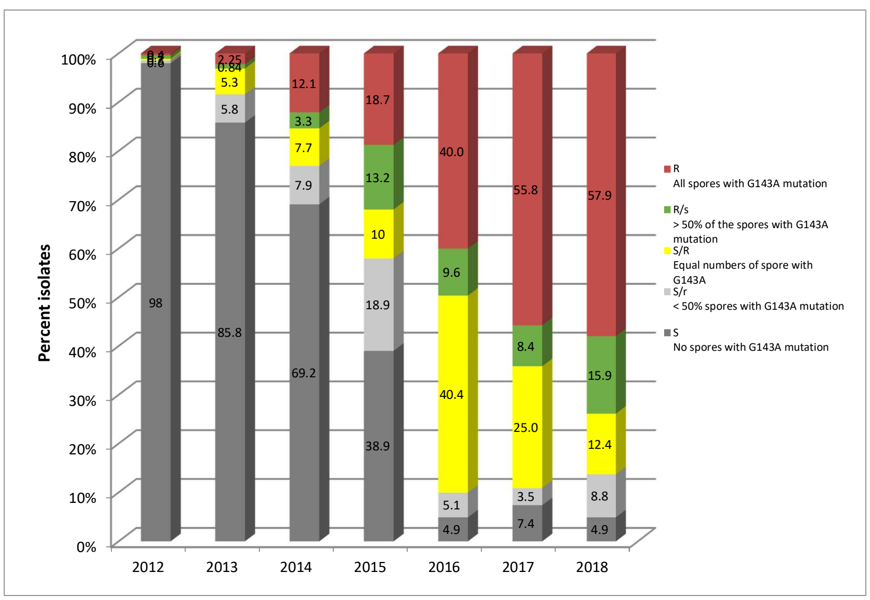
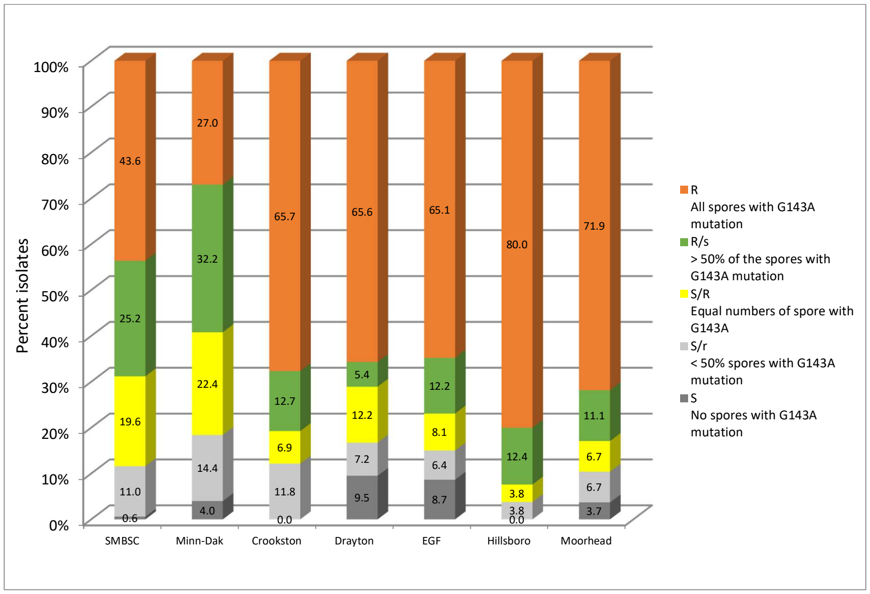


Figure 7. Sensitivity of *C. beticola* isolates collected in ND and MN in 2018 to Headline by factory district as measured by the percentage of spores with G143A mutation



SCREENING OF SUGAR BEET GERMPLASM FOR RESISTANCE TO FUSARIUM YELLOWING DECLINE.

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Fusarium spp. can lead to significant economic losses for sugar beet growers throughout the United States production region by causing reductions in yield from several associated diseases (Campbell, Fugate & Niehaus, 2011; Hanson & Hill, 2004; Hanson & Jacobsen, 2009; Stewart, 1931) including Fusarium yellows (Stewart, 1931) and Fusarium tip root (Harveson & Rush, 1998; Martyn *et al.* 1989). In 2008, a new sugar beet disease was found in the Red River Valley of MN and ND which caused *Fusarium* yellows-like symptoms but turned out to be more aggressive than Fusarium yellows (Rivera *et al.* 2008). Symptoms differed from the traditional Fusarium yellows by causing discoloration of petiole vascular elements as well as seedling infection and rapid death of plants earlier in the season. Subsequent studies confirmed that the causal agent of this disease was different from any previously described *Fusarium* species and was therefore named *F. secorum* and the disease it causes as Fusarium yellowing decline (Secor *et al.* 2014).

F. secorum was shown to belong to the *Fusarium fujikuroi* species complex whereas Fusarium yellows is primarily caused by *Fusarium oxysporum* f. sp. *betae* (Ruppel, 1991; Snyder & Hansen, 1940) but can be caused by other *Fusarium* spp. including *F. acuminatum*, *F. avenaceaum*, *F. solani,* and *F. moniliforme* (Hanson & Hill, 2004). Currently, the most effective management strategy for the more common Fusarium yellows is through the use of resistant cultivars and crop rotations with non-hosts (Harveson, Hanson & Hein, 2009) with several sugar beet germplasm being reported to have some resistance (Hanson *et al.* 2009). However, it is unknown if the resistance found in sugar beet to the more common Fusarium yellows will provide any protection against the emerging Fusarium yellowing decline. Therefore, this project proposes to screen multiple sugar beet germplasm for resistance against *F. secorum* which causes Fusarium yellowing decline.

Objectives:

Objective 1: Screen select USDA-ARS, Fort Collins Sugar beet breeding program sugar beet germplasm with known resistance for Fusarium yellows for resistance to Fusarium yellowing decline caused by *F. secorum.*

Year 1 (FY17-18): Screen susceptible sugar beet germplasm and lines with *F. secorum* and determine if differences in pathogen virulence and host susceptibility are prevalent in the population. **(Completed; manuscript submitted)**

Year 2 (FY18-19): Screen resistant sugar beet germplasm and lines with *F. secorum* and determine if resistance to Fusarium yellows also confers resistance to Fusarium yellowing decline. **(2 of 4 replications completed)**

Objective 2: Continue characterizing *F. secorum* population and evaluate phylogenetic relationship with current *F. oxysporum* f. sp. *betae* regional populations. **(Completed; manuscript submitted)**

Materials and Methods

***Fusarium* isolates**

Fusarium isolates used for these studies were obtained from the long-term culture collections located at either the USDA-ARS Soil Management and Sugar Beet Research Unit (SMSBRU) in Fort Collins, CO or from Dr. Gary Secor. Six *F. secorum* isolates (670-10; 742-28; 784-24-2C; 845-1-18; 938-4; 938-6; and 1090-4-2) and three *F. oxysporum* f. sp. *betae* isolates (F19; Fob220a; and Fob257c) were used for all inoculations. Working cultures of all isolates were maintained on potato dextrose agar plates (PDA; Becton, Dickinson, and Co., Sparks, MD) at room temperature until used, and transferred using established protocols (Leslie & Summerell, 2006). To validate identification of each isolate as either *F. secorum* or *F. oxysporum* f. sp. *betae*, each isolate was grown on ½ PDA and carnation leaf agar (CLA) at 25°C with continual lights for 3-4 weeks. Morphological characteristics were recorded according to the descriptions of *Fusarium* species (Leslie & Summerell, 2006).

Plant treatment(s)

Six susceptible and 32 resistant or tolerant sugar beet lines/germplasm were provided by the breeding program of Dr. Leonard Panella, USDA-ARS, Fort Collins, CO, SESVanderhave, Betaseeds, and Syngenta-Hilleshog for screening (data not shown). Two sets of experiments are being completed with the screening of a set of 6 susceptible lines being performed first, followed by screening of Fusarium yellows resistant lines and other lines provided by seed companies. For the first set of experiments, six susceptible lines (USH20; FC716; Monohikori; VDH46177; 902735;

and SYN07064964) were inoculated with all *Fusarium* isolates as described below. Disease severity was rated on a 0-5 Fusarium yellows rating scale (Hanson & Hill, 2004) and an area under the disease progress (AUDPC) was used to detect significant differences in pathogen aggressiveness using SAS as previously described (Webb, Brenner & Jacobsen, 2015).

Screening of the resistant sugar beet lines is being performed using an augmented split block experimental design (Federer, 2005). Briefly, germplasm are randomly assigned to one of six "sets" of inoculations. "Sets" will then represent the blocking for the statistical analysis for this experiment. Each inoculation "set" is then being used for two-three inoculation dates (experiments or replicates). Experiments are being performed as previously described by Secor et al. (2014). Briefly, sugar beet seed are planted into 6.5cm black plastic "conetainers" using pasteurized potting soil supplemented with Osmocote 14-14-14 slow release fertilizer (Scotts, Marysville, OH). Plants are grown in a greenhouse with an average daytime temperature of 24°C and average nighttime temperature of 18°C and a 16h photoperiod for 4 weeks.

***Fusarium secorum* inoculations.** Plants are inoculated at the 2-3 leaf stage by dipping the root into a spore suspension of $1x10^4$ conidia ml^{-1} for 5 min with gentle agitation (Hanson & Hill, 2004; Hanson *et al.* 2009; Burlakoti *et al.* 2012; Secor *et al.* 2014) with 5 plants being inoculated for each isolate per variety. Treated plants will be maintained in the greenhouse and evaluated for Fusarium yellowing decline symptoms on a weekly basis for 4 weeks after inoculation. Fusarium yellowing decline symptoms will be evaluated using a modified 0-5 Fusarium yellows disease severity rating (Hanson *et al.* 2009). Statistical analyses will be conducted using SAS Proc Glimmix (SAS Institute, version 9.2, Cary, NC, USA) and the best linear unbiased estimates (Blups) compared to the respective negative and positive controls.

DNA extractions and translation elongation factor PCR amplification

Fusarium isolates were grown in 50 mL potato dextrose broth (PDB; Becton, Dickinson and Co.) by inoculating with a 7 mm diameter mycelium plug taken from a fresh culture of each isolate. Liquid cultures were grown in the dark for 5-7 days at 25°C on a rotary shaker at 100 RPM. Mycelia masses were collected by pouring the filtrate through a double layer of sterile cheese cloth, rinsed with de-ionized water, and then lyophilized at -50°C for 48 h. Lyophilized tissue was ground into a fine powder using a spatula, and DNA extracted using the Invitrogen Easy-DNA extraction kit (Carlsbad, CA) utilizing the manufacturer's protocol for small amounts of plant tissues. Each isolate had 2 biological replicates for PCR amplification and DNA sequencing.

Tef1-α primers were used for PCR amplification (O'Donnell *et al.* 1998) using Thermo Scientific *Taq* polymerase (Waltham, MA) and the following PCR conditions; one cycle of 94°C for 5 min followed by 33 cycles of 94°C for 1 min, 55°C for 1 min, and an extension cycle of 72°C for 2 min, followed by final extension cycle of 72°C for 5 min using a Mastercyler gradient thermocycler (Eppendorf, Hamburg, Germany). PCR products were held at 4°C until they could be removed from the thermocycler. PCR amplicons were visualized on a 1.5% agarose gel and purified using the Epoch GenCatch PCR extraction kit (Missouri City, TX). Products were sequenced by Eurofins, MWG/Operon (Huntsville, AL) using primers used for *Tef1-α* amplification. *Tef1-α* gene sequences were manually edited and consensus sequences built using a pair-wise sequence alignment in Genious 6.1.8 (Newark, NJ) for each isolate. Novel gene sequences from *F. secorum* isolates amplified in this study can be obtained from GenBank under accession numbers MH926020-MH926026.

Results and Discussion

Little is known about the range of virulence within *F. secorum* nor how this relates to the overall *Fusarium* population previously described. We obtained *Tef1-α* sequence from seven isolates of *F. secorum* and added this data to a phylogenetic tree that includes *F. oxysporum* f. sp. *betae* (**Objective 2**). Unexpectedly, the *F. secorum* strains nested into a distinct clade (Clade B) that included several isolates previously designated as *F. oxysporum* f. sp. *betae*, suggesting those species designations are outdated. These results prompted an expanded phylogenetic analysis of the *Tef1-α* sequence from genome sequences of publicly-available *Fusarium* spp. This analysis further designated isolates previously reported as *F. oxysporum* f. sp. *betae* from Clade A as *F. commune*, a species that is not known to be a sugar beet pathogen. Sugar beet isolates within Clade C nested within the *Fusarium oxysporum* species complex, confirming those isolates as *F. oxysporum*. Whole genome analysis was performed on representative isolates from Clade B (670-10 and Fob257c) and Clade C (F19 and non-pathogenic isolate F29). Comparative genomics supports the identification of isolate Fob257c as *F. secorum* and the identification of Clade C isolates (F19/F29) with *F. commune*. Inoculation on susceptible sugar beet with differing genetic backgrounds demonstrate that *F. secorum* strains range in virulence from low to highly virulent depending on cultivar (**Objective 1**). This work has been submitted for publication and is currently under review (Webb et al. *submitted*).

Screening resistant lines is currently in progress. 32 lines have been provided by multiple seed companies and breeding programs and are being inoculated with all of the pathogenic isolates identified from the preliminary experiments above. Two of four replicates of screening has been completed with the additional replications currently in progress throughout 2019.

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PLANT PATHOLOGY LABORATORY: SUMMARY OF 2017-2018 FIELD SAMPLES

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The plant pathology laboratory at the University of Minnesota, Northwest Research and Outreach Center in Crookston receives sugarbeet samples for diagnosis every growing season. These samples have problems caused mostly by plant pathogens, insects, or abiotic causes such as chemical injury (usually herbicide) or nutrient deficiencies. This report summarizes results of samples received during the 2017 and 2018 growing seasons.

In 2017, samples were received from 54 sugarbeet fields and diagnoses are summarized in Figure 1A. *Rhizoctonia solani* was isolated from 36 fields, *Aphanomyces cochlioides* from 3, *Fusarium* from 2, and chemical injury was determined in 2 fields (= 67, 6, 4, and 4% of fields, respectively). Both *R. solani* and *A. cochlioides* were isolated from 2 fields (4%), while in some fields, no pathogens were isolated. Samples infected by *A. cochlioides* were received in early June and early July, while samples infected by *R. solani* were received from June through the end of the growing season (Fig. 1B).

In 2018, samples were received from 77 sugarbeet fields and diagnoses are summarized in Figure 2A. *Rhizoctonia solani* was isolated from 44 sugarbeet fields, *A. cochlioides* from 23, *Fusarium* from 1, and chemical injury was determined in 7 (= 57, 30, 1, and 9% of fields, respectively). Both *R. solani* and *A. cochlioides* were isolated from 9 fields (12%), and in some fields, no fungal pathogens were isolated. Samples infected by *A. cochlioides* were received mostly in July, following high rainfall in June (Fig. 2B & 3B). Samples infected by *R. solani* were received from June through August (Fig. 2B).

The number of samples received of a particular disease does not always accurately reflect the prevalence of disease. Agricultural staff and consultants may be more comfortable self-diagnosing certain diseases or they may go unnoticed if aboveground symptoms are not observed. However, similarities and differences between 2017 and 2018 were observed. The most common pathogens in both years was *R. solani* while prevalence of samples infected with *A. cochlioides* alone and with both pathogens together was higher in 2018 compared to 2017. Although rainfall was similar in both years (Fig. 3A), the high amount of rain during the month of June in 2018 (Fig. 3B) resulted in a moderate number of samples infected by *A. cochlioides* received in July. It is typical to see development of root rot due to either *R. solani* or *A. cochlioides* (or both) following periods of excess rainfall, so samples usually are received in the weeks following excess rainfall events. Based on observations of roots during sampling of 16 fields in the southern Red River Valley and southern Minnesota growing areas, infections due to *A. cochlioides* are highly under-represented in 2018 field sample results. It is likely that agriculturists in some cases are comfortable self-diagnosing the Aphanomyces infections, but in some cases, the infections are mistaken for Rhizoctonia. The number of samples received with *Fusarium* infection continued to be low in 2017 and 2018. In 2013, samples infected with *Fusarium* were received from 22 fields, but *Fusarium*-infected samples were received from three or less fields in each year from 2014 through 2018. In 2014, varieties with higher levels of resistance to *Fusarium* were being used in locations where the disease had previously been prevalent (Chris Motteberg, American Crystal Sugar Company Agronomist, personal communication), and this has likely continued. As fields and areas with *Fusarium* are documented and more people are aware of this pathogen, varieties with higher levels of resistance should continue to be used to reduce losses, inoculum production, and spread of the pathogen.

ACKNOWLEDGEMENTS

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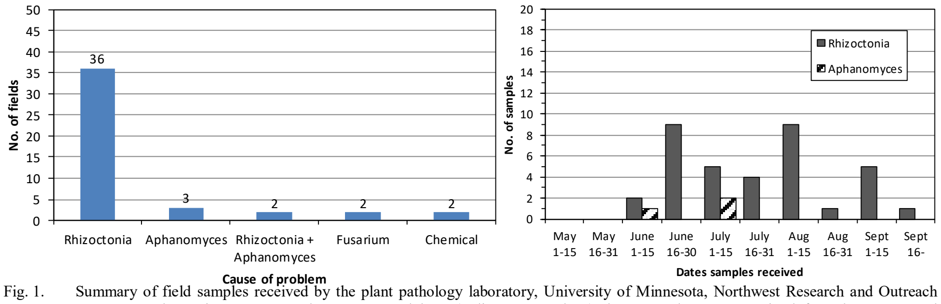

Fig. 1. Summary of field samples received by the plant pathology laboratory, University of Minnesota, Northwest Research and Outreach Center, Crookston in 2017. Results are reported by **A.**) diagnoses and **B.**) dates samples were received for *Rhizoctonia* and *Aphanomyces*, the two most common root pathogens.

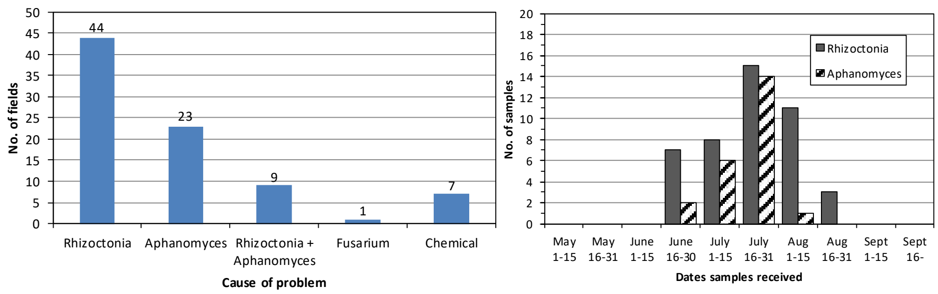

Fig. 2. Summary of field samples received by the plant pathology laboratory, University of Minnesota, Northwest Research and Outreach Center, Crookston in 2018. Results are reported by **A.**) diagnoses and **B.**) dates samples were received for *Rhizoctonia* and *Aphanomyces*, the two most common root pathogens.

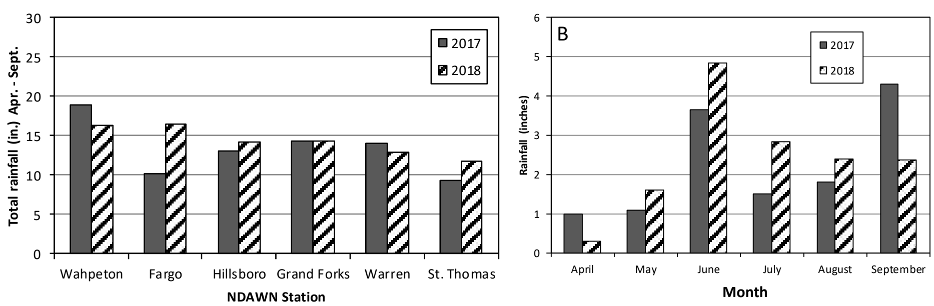

Fig. 3. Total rainfall recorded by the North Dakota Agricultural Weather Network (NDAWN) at six locations in the Red River Valley (Wahpeton, Fargo, Hillsboro, Grand Forks, Warren, MN and St. Thomas). Rainfall is reported in inches for the 2017 and 2018 growing season months of April through September. Rainfall is reported by **A.**) location and **B.**) month (averaged for all 6 locations).

SUGARBEET VARIETIES / QUALITY TESTING

NOTES

RESULTS OF AMERICAN CRYSTAL SUGAR COMPANY'S 2018 CODED OFFICIAL VARIETY TRIALS

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American Crystal Sugar Company's (ACSC) coded Official Variety Trials (OVT) are designed to provide an unbiased evaluation of the genetic potential of sugar beet variety entries under several different environments. The two-year average of these evaluations are then used to establish a list of approved varieties which ensures the use of high quality, productive varieties to maximize returns for growers and the cooperative as a whole.

This report presents data from the 2018 American Crystal OVTs and describes the procedures and cultural practices involved in the trials.

Table	Information in the Table
1	ACSC approved varieties for 2019
2	Multi-year performance of approved varieties (all locations combined)
3	Performance of ACSC Aphanomyces specialty varieties
4	Performance data of approved conventional varieties (all locations combined)
5	Disease ratings for ACSC tested varieties (multiple diseases)
6	Official trial sites, cooperators, plant and harvest dates, soil types and disease notes
7	Seed treatments applied to seed used in the OVTs
8-20	2018 Roundup Ready variety trials and combined trials
21-26	2018 Conventional variety trials and combined trials
27-30	Approval calculations for ACSC market
31	Aphanomyces disease nursery ratings
32	Cercospora disease nursery ratings
33	Rhizoctonia disease nursery ratings
34	Fusarium disease nursery ratings
35	Herbicides and fungicides applied to official trials

Procedures and Cultural Practices

Sugarbeet official variety tests were conducted at the ACSC growing region areas of the Red River Valley by ACSC personnel at the Technical Services Center.

All entries were assigned a code number by KayJay Ag Services. The seed then was sent to ACSC Technical Services Center at Moorhead for official testing.

Thirteen official yield trial sites were planted in the ACSC area with twelve harvested. Plant-to-stand trials (4.5 inch spacing) were used to evaluate the commercial, experimental and conventional varieties. Seed companies had the option of treating seed with Tachigaren, insecticide and a Rhizoctonia seed treatment fungicide. The treatments used on the seed planted in the official variety yield trials can be found in table 7.

Ten sites were used for variety approval calculations. One site was abandoned due to erratic emergence (Humbolt) and two were used for Aphanomyces Specialty (Climax and Georgetown). Rhizoctonia was prevalent in 2018 and showed an increase from 2017 in yield trials. Seed treatments and two applications of Quadris were used to control Rhizoctonia. Based upon susceptible plot observations, root aphids were present in low levels at nine (9) sites. Preliminary root aphid evaluations are in progress, but seed companies may know tolerance levels of their varieties.

Plots were planted crosswise (90°) to the cooperators' normal farming operations, where possible. Plot row lengths for all official trials were maintained at 46 feet with about 39 feet harvested. Planting was performed with a 12-

row SRES vacuum planter. The GPS controlled planter gave good single seed spacing which facilitated emergence counting. Seed companies had the option of treating seed with Tachigaren, insecticide and a Rhizoctonia seed treatment fungicide. Emergence counts were taken on 24 feet of each plot. Multiple seedlings were counted as a single plant if they emerged less than one inch apart. The stands in all yield trials were refined by removing doubles (multiple seedlings less than 1.5 inch apart) by hand but were not further reduced.
Roundup Powermax with Event and full rates of fungicides were applied using a pickup sprayer driven down the alleys. Hand weeding was used where necessary. The micro rate program was used on conventional trials. All yield trials were treated with Quadris in a band during the 2 leaf (9 oz) and 6-10 leaf stage (14 oz) for Rhizoctonia control. Treatments used for Cercospora control in 2018 included Inspire XT/Penncozeb, Agri Tin/Incognito, Proline/Penncozeb, and Headline/Agri Tin. Ground spraying was conducted by ACSC technical staff.

RR varieties with commercial seed were planted in four-row, six replication trials. The RR experimental entries were planted in smaller two-row, four replication trials. Two applications of Roundup were made in the 4-6 (32 oz) and 8 – 12 (22 oz) leaf stages.

All plot rows were measured for total length after approximately 3.5 feet at each end were removed at the end of August, with skips greater than 60 inches being measured for adjustment purposes. Harvest was performed with two modified four-row harvesters (4310 and 4310A John Deere). All harvested beets of each plot were used for yield determination while one sample (approx 25 lbs) for sugar and impurity analysis was obtained from each plot. Quality analysis was performed at the ACSC Technical Services quality lab in Moorhead.

Varieties were planted in disease nurseries in North Dakota, Minnesota and Michigan to evaluate varieties for disease tolerance.

ACSC adjusts the Cercospora, Aphanomyces, Rhizoctonia and Fusarium nursery data each year to provide a consistent target for variety approval criteria.

Acknowledgements

Thanks to the beet seed companies for their participation in the official variety testing program and to all grower-cooperators, agricultural, and beet seed staff for their assistance. Special thanks are extended to Dr. Mohamed Khan for Cercospora nursery infection, Dr. Albert Sims for hosting a Rhizoctonia nursery, Randy Nelson for RRV disease ratings, USDA staff in Michigan for Cercospora and Rhizoctonia nursery ratings. The Betaseed staff for Aphanomyces and Cercospora ratings in the Shakopee area, and Kay Jay Ag Services for sampling and coding all variety entries.

Table 1.

Varieties Meeting ACSC Approval Criteria for the 2019 Sugarbeet Crop ++

Roundup Ready ®	Full Market	Aph Spec	Rhc Spec	High Rzm
BTS 80RR52	Yes	Yes		Hi Rzm
BTS 8337	Yes	Yes		Hi Rzm
BTS 8500	Yes	Yes		Hi Rzm
BTS 8524	Yes	Yes		Hi Rzm
BTS 8606	Yes			Hi Rzm
BTS 8629	Yes	New		Hi Rzm
BTS 8735	New	New		Hi Rzm
BTS 8749	New	New		Hi Rzm
BTS 8767	New			Hi Rzm
BTS 8784	New			
Crystal 093RR	Yes	Yes		Hi Rzm
Crystal 247RR	Yes			Hi Rzm
Crystal 355RR	Yes	Yes	Yes	Hi Rzm
Crystal 467RR	Yes	Yes		Hi Rzm
Crystal 572RR	Yes			Hi Rzm
Crystal 573RR	Yes	Yes		Hi Rzm
Crystal 574RR	Yes	Yes		Hi Rzm
Crystal 578RR	Yes	New		Hi Rzm
Crystal 684RR	Yes	Yes		Hi Rzm
Crystal 792RR	New	New		Hi Rzm
Crystal 793RR	New	New		Hi Rzm
Crystal 796RR	New	New		Hi Rzm
Hilleshög HM4302RR	Yes		Yes	Rzm
Hilleshög HM4448RR	Yes			Rzm
Hilleshög HM9528RR	Yes	Yes		Hi Rzm
Hilleshög HIL9708	Yes			Hi Rzm
Hilleshög HIL9920	New			Hi Rzm
Maribo MA109	Yes	Yes	Yes	Hi Rzm
Maribo MA305	Yes			Rzm
Maribo MA502	Yes	Yes		Hi Rzm
Maribo MA504	Yes			Hi Rzm
Maribo MA717	New			Hi Rzm
Seedex Avalanche (858)	Yes	Yes		Hi Rzm
Seedex Bronco RR (1863)	Yes	Yes		Hi Rzm
Seedex Canyon RR(844TT)	Yes	Yes		Hi Rzm
Seedex Cruze RR(846)	Yes	Yes		Rzm
Seedex Marathon (856)	Yes			Hi Rzm
Seedex RR1879	New	Yes		Hi Rzm
SESVdh RR265	Yes			Hi Rzm
SESVdh RR266	Yes			Hi Rzm
SESVdh RR268	Yes	Yes		Hi Rzm
SESVdh RR333	Yes	Yes		Hi Rzm
SESVdh RR351	Yes	Yes		Hi Rzm
SESVdh RR371	New			Hi Rzm

Conventional	Full Market	High Rzm
BETA EXP 687	Yes	Hi Rzm
BETA EXP 698	Yes	Hi Rzm
BETA EXP 747	Yes	Hi Rzm
BETA EXP 758	Yes	Hi Rzm
BETA EXP 872	New	Hi Rzm
Crystal R761	Yes	Hi Rzm
Crystal 620	Yes	Hi Rzm
Crystal 840	New	Hi Rzm
Hilleshög HM3035Rz	Yes	Rzm
Hilleshög HIL9891Rz	Yes	Rzm
Maribo MA615Rz	Yes	Rzm
Seedex Deuce (SX0873TT)	Yes	Hi Rzm
Seedex 8869 Cnv	Yes	Hi Rzm
SESVanderhave 48611	Yes	Hi Rzm
SESVanderhave 48777	Yes	Hi Rzm

++Roundup Ready sugarbeets are subject to the ACSC RRSB Bolter Destruction Policy Created 11/6/2018

Roundup Ready ® is a registered trademark of Monsanto Company.

Aph Spec = variety meets Aphanomyces specialty requireme
Rhc Spec = variety meets Rhizoctonia specialty requirement
Hi Rzm = may perform better under severe Rzm.
New = newly approved

Table 2. Performance Data of RR Varieties During 2016, 2017, 2018 Growing Seasons (All Locations Combined) +++

	Yrs	Rev/Ton ++					Rev/Acre ++					Rec/Ton		Rec/Acre		Sugar		Yield		Molasses		Emerg		Bolter / Ac		CR +		Aph Root+		Rhizoc.+		Fusarium+		Rzm+
Variety	Com	18	2 Yr	2Y%	3Yr#	3Y%	18	2 Yr	2Y%	3Yr#	3Yr%	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	
Previous Approved # locations		10	20		29		10	20		29		10	20	10	20	10	20	10	20	10	20	10	20	10	20	3	6	2	3	3	4	2	4	
BTS 80RR52	7	53.98	53.39	99	52.74	99	1536	1618	97	1732	99	347	340	9939	10364	18.36	18.15	28.9	30.7	1.03	1.13	86	82	0	2	4.38	4.38	4.5	4.4	4.0	4.1	3.8	3.2	Hi
BTS 8337	4	56.93	57.18	106	56.15	106	1619	1731	104	1779	102	357	353	10209	10709	18.81	18.68	28.8	30.5	0.98	1.03	81	78	0	2	4.64	4.50	3.7	3.8	4.1	4.2	4.2	4.0	Hi
BTS 8500	2	53.18	53.21	99	51.79	98	1719	1791	108	1849	106	344	340	11242	11492	18.18	18.04	33.2	34.1	0.99	1.05	88	82	0	0	4.40	4.34	4.4	4.5	4.4	4.5	2.5	2.3	Hi
BTS 8524	2	50.28	50.90	94	49.96	94	1658	1727	104	1803	103	334	332	11083	11295	17.72	17.68	33.5	34.2	1.05	1.10	81	80	0	2	4.50	4.44	4.1	4.3	4.2	4.3	3.9	3.6	Hi
BTS 8606	1	54.93	54.79	102	53.71	101	1684	1783	107	1855	106	350	345	10811	11275	18.44	18.29	31.2	32.9	0.95	1.02	83	81	0	0	4.80	4.76	4.4	4.7	4.2	4.6	3.7	3.2	Hi
BTS 8629	1	53.05	52.71	98	51.34	97	1752	1818	109	1864	107	343	338	11437	11712	18.13	17.93	33.7	34.9	0.97	1.03	73	77	0	0	4.52	4.40	3.9	4.3	4.0	4.1	4.4	4.3	Hi
Crystal 093RR	7	56.72	57.19	106	55.51	105	1666	1766	106	1825	105	356	353	10529	10934	18.81	18.71	29.8	31.1	1.01	1.05	87	82	0	0	4.88	4.68	4.4	4.4	4.6	4.5	4.3	3.9	Hi
Crystal 247RR	5	53.68	53.39	99	52.50	99	1669	1751	105	1838	105	345	340	10826	11201	18.21	18.00	31.6	33.1	0.95	0.99	84	80	0	9	4.54	4.55	5.0	5.2	4.6	4.5	3.3	3.2	Hi
Crystal 355RR	3	55.03	54.80	102	54.25	102	1524	1618	97	1727	99	350	345	9770	10230	18.56	18.36	28.1	29.8	1.05	1.10	88	82	0	0	4.52	4.44	4.4	4.6	3.7	3.9	3.7	3.2	Hi
Crystal 467RR	1	52.39	51.98	96	50.19	95	1653	1729	104	1767	101	341	336	10852	11220	18.04	17.84	32.2	33.7	0.99	1.06	86	83	0	0	4.61	4.53	3.7	3.8	3.9	4.2	2.9	2.4	Hi
Crystal 572RR	2	56.30	57.65	107	56.34	106	1718	1805	109	1864	107	355	355	10882	11131	18.70	18.72	30.9	31.5	0.97	0.99	83	82	0	0	4.45	4.36	4.5	4.6	4.5	4.5	3.7	3.2	Hi
Crystal 573RR	1	56.24	55.95	104	54.89	103	1711	1748	105	1822	104	354	349	10852	10945	18.68	18.48	30.9	31.5	0.97	1.03	88	82	0	0	4.38	4.26	4.3	4.1	4.3	4.4	4.2	3.7	Hi
Crystal 574RR	2	52.84	52.84	98	51.45	97	1733	1804	109	1893	108	343	338	11330	11591	18.14	17.97	33.4	34.4	1.01	1.05	83	81	0	0	4.42	4.38	4.3	4.5	4.4	4.3	2.9	2.6	Hi
Crystal 578RR	1	53.99	54.02	100	53.12	100	1645	1772	107	1854	106	347	342	10637	11272	18.31	18.15	31.0	33.1	0.99	1.03	86	83	0	0	4.74	4.83	4.2	4.4	4.3	4.3	3.4	2.9	Hi
Crystal 684RR	NC	52.81	52.73	98	51.42	97	1756	1827	110	1922	110	342	338	11480	11769	18.13	17.97	33.9	35.0	1.02	1.07	88	84	0	0	4.41	4.38	3.8	4.1	4.4	4.5	3.0	2.5	Hi
Hilleshög HM4302RR	5	53.22	52.98	98	52.53	99	1572	1585	95	1657	95	344	339	10241	10167	18.14	17.95	30.1	30.1	0.95	1.00	82	73	0	0	4.26	4.09	4.7	5.7	3.7	3.7	5.0	5.1	Rzm
Hilleshög HM4448RR	5	54.07	54.00	100	52.34	99	1720	1775	107	1807	104	347	342	11133	11295	18.29	18.13	32.5	33.2	0.95	1.01	84	77	0	2	5.26	5.27	4.5	5.4	4.4	4.5	5.2	5.3	Rzm
Hilleshög HM9528RR	4	53.42	53.89	100	53.31	100	1632	1709	103	1800	103	345	342	10603	10879	18.17	18.10	31.1	32.0	0.94	1.00	78	76	0	2	4.79	4.89	4.2	4.9	4.0	4.1	5.0	4.6	Hi
Hilleshög HIL9708	1	54.10	54.10	100	52.76	99	1684	1662	100	1727	99	347	343	10848	10569	18.30	18.16	31.5	30.9	0.95	1.01	85	80	0	5	4.71	4.66	4.2	5.1	3.7	4.0	4.6	4.6	Hi
Maribo MA109	3	56.22	56.54	105	56.47	106	1522	1546	93	1660	95	354	351	9663	9621	18.68	18.56	27.5	27.5	0.97	1.02	76	72	0	0	4.33	4.23	4.4	4.7	3.7	3.7	4.9	4.6	Hi
Maribo MA305	3	51.36	51.70	96	50.64	95	1589	1660	100	1698	97	337	335	10549	10784	17.81	17.71	31.7	32.4	0.94	0.98	76	71	0	0	4.92	4.95	4.9	5.3	4.3	4.4	5.5	5.7	Rzm
Maribo MA502	2	50.80	51.13	95	49.81	94	1520	1581	95	1662	95	335	333	10126	10333	17.82	17.74	30.5	31.3	1.05	1.11	82	78	0	34	4.95	4.98	3.7	3.6	4.2	4.5	3.3	3.2	Hi
Maribo MA504	2	52.98	52.84	98	51.22	96	1748	1789	108	1836	105	343	338	11406	11519	18.14	17.96	33.6	34.2	0.99	1.03	84	81	0	0	4.98	5.24	5.3	5.7	4.2	4.3	4.8	4.7	Hi
SV RR265	1	53.20	53.38	99	52.54	99	1663	1750	105	1826	105	344	340	10824	11204	18.11	18.00	31.8	33.1	0.93	0.98	84	79	0	0	4.48	4.83	4.2	4.8	4.3	4.4	5.4	5.4	Hi
SV RR266	1	53.71	53.79	100	53.04	100	1644	1729	104	1810	104	346	342	10651	11028	18.22	18.08	31.1	32.5	0.95	0.99	73	70	0	0	4.73	4.67	4.7	5.2	4.3	4.4	5.7	5.7	Hi
SV RR268	1	55.08	54.95	102	53.98	102	1679	1741	105	1812	104	350	346	10767	11006	18.47	18.28	31.1	32.1	0.96	0.99	81	78	0	0	4.70	4.88	4.2	4.5	4.2	4.4	5.1	5.1	Hi
SV RR333	3	55.32	54.77	102	53.81	101	1642	1733	104	1805	103	351	345	10483	10941	18.50	18.24	30.0	31.8	0.95	1.00	75	74	0	0	4.78	4.81	4.1	4.5	4.2	4.3	5.1	5.2	Hi
SV RR351	2	54.24	53.99	100	52.76	99	1661	1722	104	1805	103	347	342	10715	10956	18.30	18.11	31.1	32.1	0.93	0.99	79	76	0	0	4.61	4.51	4.5	4.3	4.2	4.2	5.3	5.1	Hi
SX Avalanche RR	2	54.64	54.93	102	54.14	102	1582	1636	99	1729	99	349	346	10157	10315	18.37	18.25	29.3	30.0	0.93	0.98	81	76	0	5	4.50	4.57	4.2	4.1	4.4	4.3	5.4	5.6	Hi
SX Bronco RR(1863)	1	54.70	54.96	102	54.43	103	1647	1710	103	1809	104	349	346	10588	10798	18.41	18.27	30.6	31.4	0.96	0.98	77	72	0	0	4.65	4.37	4.0	4.5	4.7	4.5	5.5	5.8	Hi
SX Canyon RR	3	53.83	54.55	101	53.57	101	1674	1752	105	1810	104	346	344	10832	11081	18.25	18.20	31.6	32.3	0.95	0.99	81	76	0	0	4.79	4.85	4.3	4.3	4.4	4.4	4.9	5.0	Hi
SX Cruze RR	3	46.25	47.13	88	46.77	88	1465	1581	95	1624	93	320	319	10190	10731	17.08	17.07	32.1	33.8	1.10	1.12	60	69	0	2	5.79	5.58	4.4	4.6	4.2	4.3	4.8	4.4	Rzm
SX Marathon RR	2	54.20	54.43	101	53.28	100	1717	1765	106	1856	106	347	344	11063	11180	18.30	18.17	32.1	32.7	0.94	0.98	83	77	0	2	5.27	4.90	4.7	4.6	4.2	4.3	5.5	5.2	Hi
Newly Approved																																		
BTS 8735	NC	56.10	54.67	101	--	--	1689	1762	106	--	--	354	345	10770	11176	18.63	18.24	30.8	32.6	0.93	0.99	86	82	0	0	4.21	4.22	4.0	4.4	4.1	4.3	4.0	4.0	Hi
BTS 8749	NC	54.31	54.06	100	--	--	1596	1657	100	--	--	348	343	10289	10551	18.40	18.22	29.8	31.0	1.01	1.08	85	81	0	5	4.10	4.08	2.8	3.2	3.9	3.9	3.8	3.5	Hi
BTS 8767	NC	53.49	53.88	100	--	--	1664	1771	107	--	--	345	342	10810	11282	18.21	18.13	31.6	33.2	0.97	1.03	88	85	0	0	4.32	4.24	4.3	4.5	4.1	4.4	3.4	3.1	Hi
BTS 8784	NC	57.22	57.54	107	--	--	1667	1727	104	--	--	358	355	10483	10679	18.82	18.72	29.4	30.2	0.93	0.98	85	81	0	0	3.73	3.69	4.2	4.4	4.6	4.6	3.8	3.2	Hi
Crystal 792RR	NC	54.97	55.32	103	--	--	1684	1741	105	--	--	350	347	10791	10965	18.48	18.37	31.0	31.7	0.98	1.02	85	81	0	0	4.26	4.10	3.8	4.3	4.2	4.0	3.5	3.2	Hi
Crystal 793RR	NC	56.87	56.78	105	--	--	1804	1850	111	--	--	357	352	11373	11504	18.74	18.56	32.1	32.8	0.90	0.95	85	82	0	9	4.26	4.10	3.3	3.2	4.1	4.2	3.6	3.3	Hi
Crystal 796RR	NC	53.70	53.66	100	--	--	1743	1846	111	--	--	345	341	11306	11771	18.24	18.09	33.0	34.7	0.96	1.02	87	84	0	0	4.74	4.79	3.6	3.4	4.0	4.1	3.4	2.8	Hi
Hilleshög HIL9920	NC	56.44	56.53	105	--	--	1695	1740	105	--	--	355	351	10745	10857	18.69	18.55	30.5	31.1	0.94	0.98	85	80	0	5	4.79	4.84	4.1	4.5	4.6	4.6	5.5	5.7	Hi
Maribo MA717	NC	56.21	55.65	103	--	--	1666	1704	103	--	--	354	348	10573	10700	18.68	18.44	30.0	30.8	0.96	1.02	87	81	0	0	4.78	4.81	4.2	4.7	4.3	4.3	4.9	4.9	Hi
SV RR371	NC	53.84	54.03	100	--	--	1622	1728	104	--	--	346	343	10508	10992	18.24	18.11	30.6	32.2	0.94	0.98	83	80	0	0	4.71	4.65	4.5	4.5	4.2	4.3	5.4	5.1	Hi
SX RR1879	NC	54.16	54.12	100	--	--	1652	1711	103	--	--	347	343	10680	10886	18.28	18.13	31.1	31.9	0.92	0.98	85	80	0	0	4.44	4.66	4.4	4.3	4.3	4.3	5.2	4.9	Hi
Benchmark var. mean		53.92	53.86		53.08		1585	1661		1746		346	342	10254	10585	18.35	18.20	29.9	31.1	1.03	1.10	85	81											

3 Yr is mean of 3 years data, 3 Y% is 3-Yr mean as % of benchmark varieties. 2 Yr is mean of 2 years data, 2 Y% is 2-Yr mean as % of benchmark varieties. Emergence is % of planted seeds producing a 4 leaf beet. Created 10/30/2018.

++2018 Revenue estimate based on a $46.40 beet payment (5-yr ave) at 17.5% crop with a 1.5% loss to molasses, 2017 Revenue estimate based on a $48.49 beet payment and 2016 Revenue estimate based on a $52.44 beet payment. Revenue does not consider hauling or production costs.

+ Aph ratings from RRV & Shakopee (res.<4.4, susc>5.0). CR from Randolph MN, Foxhome MN & Michigan (res.<4.4, susc>5.5). Fusarium from RRV (res.<3.0, susc>5.0). Rhizoc. from Mhd, NWROC & Mich (res.<3.8, susc>5). Hi may perform better under s

Bolters /Ac are based upon a plant stand of 45,000. +++ Sites include Casselton, Averill, Ada, Hillsboro, Fisher, Crookston, Grand Forks, St Thomas, Stephen in 2016.

-- indicates data not available. +++ Sites include Felton, Georgetown, Hillsboro, Climax, Grand Forks, Stephen, Scandia, St. Thomas, Hendrum, Bathgate in 2017.

+++ Sites include Casselton, Bathgate, Scandia, East Grand Forks, St. Thomas, Ada, Glyndon, Hillsboro, Grand Forks, Stephen in 2018

Table 3. Performance Data of RR Aphanomyces Specialty Varieties - Under Aphanomyces Conditions (Relative to Susceptible Checks) approved for 2019 Growing Season +++

	Years	Rev/Ton			Rev/Acre			Rec/Ton		Rec/Acre		Sugar		Yield		CR Rating +		Aph Root +		Fusarium +		Rhizoctonia +	
Description	Comm	2018	2016#	%Sus	2018	2016#	%Sus	2018	2016#	2018	2016#	2018	2016#	2018	2016#	18	2Yr	18	2 Yr	18	2Yr	18	2Yr
# of locations		2	2	4	2	2	4	2	2	2	2	2	2	2	2	3	6	2	3	2	4	3	4
Previously Approved																							
BTS 80RR52	7	40.90	47.73	101	1181	1294	131	300.8	305.0	8663	8994	16.27	16.32	28.8	29.5	4.38	4.38	4.5	4.4	3.8	3.2	4.0	4.1
BTS 8337	4	44.69	49.32	107	1240	1306	132	314.0	310.0	8719	8626	16.83	16.59	27.8	27.9	4.64	4.50	3.7	3.8	4.2	4.0	4.1	4.2
BTS 8500	2	39.44	44.32	95	1309	1318	133	295.7	293.9	9794	8817	15.97	15.79	33.1	30.1	4.40	4.34	4.4	4.5	2.5	2.3	4.4	4.5
BTS 8524	2	35.94	44.53	91	1185	1301	131	283.5	294.6	9388	9385	15.40	15.85	33.2	31.9	4.50	4.44	4.1	4.3	3.9	3.6	4.2	4.3
Crystal 093RR	7	40.91	49.26	103	1244	1312	132	300.8	309.9	9138	8685	16.27	16.61	30.3	28.1	4.88	4.68	4.4	4.4	4.3	3.9	4.6	4.5
Crystal 355RR	3	40.82	49.37	103	1131	1205	122	300.5	310.2	8333	8071	16.24	16.58	27.9	26.1	4.52	4.44	4.4	4.6	3.7	3.2	3.7	3.9
Crystal 467RR	1	37.00	42.00	90	1171	1208	122	287.2	286.1	9090	8510	15.56	15.48	31.6	29.9	4.61	4.53	3.7	3.8	2.9	2.4	3.9	4.2
Crystal 573RR	1	42.09	48.78	103	1273	1288	130	305.0	308.8	9210	8294	16.46	16.51	30.2	27.0	4.38	4.26	4.3	4.1	4.2	3.7	4.3	4.4
Crystal 574RR	2	38.17	44.17	94	1282	1321	133	291.3	293.4	9778	9003	15.75	15.76	33.6	30.5	4.42	4.38	4.3	4.5	2.9	2.6	4.4	4.3
Crystal 684RR	NC	37.30	44.83	93	1295	1406	142	287.9	295.6	10015	9986	15.60	15.89	34.9	33.7	4.41	4.38	3.8	4.1	3.0	2.5	4.4	4.5
Hilleshög HM4302RR	5	40.29	47.43	100	1087	1092	110	298.7	304.0	8026	6975	16.03	16.25	26.8	22.9	4.26	4.09	4.7	5.7	5.0	5.1	3.7	3.7
Hilleshög HM9528RR	4	38.65	48.08	99	1157	1268	128	293.0	306.1	8781	8772	15.71	16.38	30.0	28.6	4.79	4.89	4.2	4.9	5.0	4.6	4.0	4.1
Maribo MA109	3	42.36	51.46	107	1048	1114	112	305.9	316.9	7569	7271	16.40	16.91	24.8	23.0	4.33	4.23	4.4	4.7	4.9	4.6	3.7	3.7
Maribo MA502	2	40.07	44.36	96	1186	1268	128	297.9	294.0	8788	8945	16.09	15.88	29.4	30.4	4.95	4.98	3.7	3.6	3.3	3.2	4.2	4.5
SV RR268	1	41.55	48.64	103	1236	1271	128	303.1	308.4	9007	8262	16.28	16.40	29.8	26.7	4.70	4.88	4.2	4.5	5.1	5.1	4.2	4.4
SV RR333	3	41.41	46.56	100	1172	1207	122	302.6	301.2	8553	8010	16.25	16.08	28.2	26.5	4.78	4.81	4.1	4.5	5.1	5.2	4.2	4.3
SV RR351	2	41.26	46.82	100	1201	1293	131	302.1	302.2	8798	8971	16.25	16.16	29.2	29.7	4.61	4.51	4.5	4.3	5.3	5.1	4.2	4.2
SX Avalanche RR	2	42.51	48.30	103	1154	1242	125	306.4	307.2	8324	8473	16.41	16.37	27.2	27.6	4.50	4.57	4.2	4.1	5.4	5.6	4.4	4.3
SX Bronco RR(1863)	1	42.51	50.16	105	1232	1291	130	306.4	313.4	8859	8434	16.36	16.62	28.9	26.9	4.65	4.37	4.0	4.5	5.5	5.8	4.7	4.5
SX Canyon RR	3	40.07	44.98	97	1199	1200	121	297.9	296.2	8884	7852	16.05	15.86	29.7	26.3	4.79	4.85	4.3	4.3	4.9	5.0	4.4	4.4
SX Cruze RR	3	33.43	42.40	86	1041	1181	119	274.7	288.0	8545	8957	14.99	15.51	31.1	31.0	5.79	5.58	4.4	4.6	4.8	4.4	4.2	4.3
Newly Approved																							
BTS 8629	1	38.57	44.43	94	1286	1332	134	292.7	294.2	9772	9079	15.82	15.81	33.4	30.7	4.52	4.40	3.9	4.3	4.4	4.3	4.0	4.1
BTS 8735	NC	40.15	--	--	1215	--	--	298.2	--	9035	--	16.04	--	30.4	--	4.21	4.22	4.0	4.4	4.0	4.0	4.1	4.3
BTS 8749	NC	39.62	--	--	1201	--	--	296.4	--	9005	--	16.02	--	30.5	--	4.10	4.08	2.8	3.2	3.8	3.5	3.9	3.9
Crystal 578RR	1	39.56	47.50	99	1156	1318	133	296.1	304.5	8661	9500	15.96	16.25	29.3	31.2	4.74	4.83	4.2	4.4	3.4	2.9	4.3	4.3
Crystal 792RR	NC	42.16	--	--	1343	--	--	305.5	--	9758	--	16.39	--	32.0	--	4.26	4.10	3.8	4.3	3.5	3.2	4.2	4.0
Crystal 793RR	NC	42.26	--	--	1317	--	--	305.8	--	9553	--	16.37	--	31.3	--	4.26	4.10	3.3	3.2	3.6	3.3	4.1	4.2
Crystal 796RR	NC	38.87	--	--	1288	--	--	293.5	--	9735	--	15.82	--	33.2	--	4.74	4.79	3.6	3.4	3.4	2.8	4.0	4.1
SX RR1879	NC	40.45	--	--	1213	--	--	299.3	--	8985	--	16.04	--	30.1	--	4.44	4.66	4.4	4.3	5.2	4.9	4.3	4.3
Aph Susc Checks		39.78	48.17		956	1025		296.9	306.8	7123	6529	16.04	16.49	24.0	21.3								
Mean of Aph Specialty Varieties		40.10	46.76		1208	1331		298.0	301.9	8992	8603	16.06	16.17	30.2	28.5								

%Susc = % of susceptible varieties. Created 11/6/2018

+ Aph ratings from RRV & Shakopee (res.<4.4, susc>5.5). CR from Randolph MN, Foxhome MN & Michigan (res.<4.4, susc>5.5). Fusarium from RRV (res.<3.0, susc>5.0). Rhizoc. from Mhd,

++ 2018 Revenue estimates based on a $46.40beet payment at 17.5% sugar and 1.5% loss to molasses. Revenue does not consider hauling or production costs.

+++ 2018Data from Climax and Georgetown.

Lack of Aphanomyces pressure at any of the OVT sites prevented collection of Aphanomyces Yield Data for 2017.

Table 4. Performance Data of Conventional Varieties During 2016, 2017, 2018 Growing Seasons (All Locations Combined)

	Yrs	Rev/Ton ++					Rev/Acre ++					Rec/Ton		Rec/Acre		Sugar		Yield		Molasses		Emerg		Bolter / Ac		CR +		Aph Root+		Rhizoc.+		Fusarium+		Rzm+
Variety @	Com	18	2 Yr	2Y%	3Yr#	3Y%	18	2 Yr	2Y%	3Yr#	3Yr%	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	18	2 Yr	
Previous Approved # locati		5	16		17		5	16		17		5	16	5	16	5	16	5	16	5	16	5	16	5	16	3	6	2	3	3	6	2	4	
BETA EXP 687	NC	53.73	54.92	118	54.45	116	1698	1666	112	1753	100	346	345	11006	10565	18.40	18.44	32.1	30.9	1.12	1.17	84	78	0	0	3.90	3.95	4.1	4.2	3.8	4.0	3.9	3.7	Hi
BETA EXP 698	NC	51.36	52.29	112	52.03	111	1831	1723	116	1801	102	337	336	12134	11219	17.93	17.93	36.3	33.7	1.06	1.10	80	78	0	0	4.18	4.18	3.7	3.7	4.2	4.3	3.3	3.2	Hi
BETA EXP 747	NC	53.57	53.08	114	--	--	1907	1780	120	--	--	345	339	12377	11467	18.18	18.01	36.2	34.1	0.93	1.04	82	78	0	0	4.25	4.32	4.0	3.8	4.1	4.0	4.7	4.6	Hi
BETA EXP 758	NC	51.26	52.57	113	--	--	1731	1685	113	--	--	337	337	11501	10916	17.91	17.97	34.5	32.7	1.06	1.10	84	81	10	5	4.22	4.37	3.7	3.5	4.0	4.1	4.2	4.1	Hi
Crystal R761	9	48.44	49.78	107	49.60	106	1789	1740	117	1762	100	327	328	12172	11534	17.53	17.63	37.5	35.4	1.17	1.23	83	78	0	0	4.72	4.82	4.1	4.0	4.4	4.4	4.1	3.7	Hi
Crystal 620	NC	52.73	53.35	115	52.94	113	1867	1787	120	1839	104	342	340	12221	11502	18.16	18.11	36.1	34.1	1.05	1.10	79	74	0	0	4.30	4.22	3.8	3.9	4.2	4.3	3.5	3.1	Hi
Hilleshög HM3035Rz	12	54.57	54.45	117	54.57	116	1464	1461	98	1566	89	349	344	9405	9294	18.38	18.28	27.2	27.3	0.97	1.09	70	75	0	9	4.23	4.33	5.2	5.2	4.0	4.0	4.5	4.1	Rzm
Hilleshög 9891Rz	2	53.03	53.99	116	53.61	114	1563	1522	102	1578	90	343	342	10198	9733	18.18	18.22	30.0	28.7	1.03	1.11	84	81	10	5	4.23	4.18	4.7	4.8	3.8	4.1	3.6	3.6	Rzm
Maribo MA615Rz	NC	47.49	49.60	107	50.36	107	1640	1613	109	1732	98	324	327	11277	10734	17.43	17.62	35.1	33.0	1.23	1.25	80	80	0	0	4.58	4.70	4.7	5.0	4.4	4.5	4.9	4.8	Rzm
Seedex 8869 Cnv	NC	50.05	52.06	112	52.23	111	1859	1800	121	1869	106	333	336	12448	11695	17.60	17.81	37.7	35.1	0.97	1.03	84	80	10	5	4.66	4.94	4.8	4.9	4.6	4.5	3.8	3.6	Hi
Seedex Deuce	NC	51.50	52.70	113	52.93	113	1885	1838	124	1883	107	338	338	12417	11832	17.90	17.95	36.9	35.1	1.02	1.06	83	79	10	14	4.74	4.75	5.3	5.7	4.5	4.5	5.0	4.8	Hi
SV 48611	NC	55.21	55.37	119	54.88	117	1868	1769	119	1818	103	351	347	11930	11128	18.52	18.41	34.2	32.2	0.99	1.06	81	75	0	0	4.95	5.12	4.6	4.4	4.5	4.4	5.7	5.7	Hi
SV 48777	NC	55.32	56.36	121	--	--	1815	1758	118	--	--	351	350	11565	10987	18.47	18.48	33.1	31.5	0.92	0.97	83	78	0	0	4.56	4.66	5.1	4.7	4.5	4.5	4.5	4.2	Hi
Newly Approved																																		
BETA EXP 872	NC	52.63	--	--	--	--	1874	--	--	--	--	342	--	12279	--	18.18	--	36.3	--	1.08	--	71	--	0	0	4.82	--	3.9	--	4.4	--	3.7	--	Hi
Crystal 840	NC	51.66	--	--	--	--	1882	--	--	--	--	338	--	12429	--	17.96	--	37.1	--	1.04	--	77	--	0	0	4.33	--	3.8	--	4.0	--	3.6	--	Hi
Benchmark var. mean		53.39	46.52		46.95		1762	1486		1760		344	338	11444	10867	18.30	18.10	33.5	32.4	1.08	1.18	84	80											

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

++ 2018 Revenue estimate based on a $46.40 beet payment (5-yr ave) at 17.5% sugar and 1.5% loss to molasses.

+ Aph ratings from OVT's and Shakopee (res<4.4, susc>5.5). CR from Randolph MN, Foxhome MN & Michigan (res<4.5, susc>5.2). Fusarium from RRV (res<3.0, susc>5.0). Rhizoc. from Mhd, NWROC & Mich (res<3.8, susc>5).

Hi may perform better under severe Rzm.

Bolters /Ac are based upon a plant stand of 45,000.

+++ Sites include Casselton, Hendrum, Grand Forks, Scandia, St. Thomas, Humbolt in 2017.

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

Table 5. Official Trial Disease Nurseries 2016 - 2018(Varieties tested in 2018)
Cercospora, Aphanomyces, Rhizoctonia & Fusarium

		< 4.5 CR > 5.0					< 4.4 Aph > 5.5					< 3.82 Rhizoctonia > 5.0					< 3.0 Fusarium > 5.0					High Rzm
		18	17	16	2 Yr	3 Yr	18	17	16	2 Yr	3 Yr	18	17	16	2 Yr	3 Yr	18	17	16	2 Yr	3 Yr	
Code	Description +	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	
	ACSC Commercial																					
570	BTS 80RR52	4.38	4.37	4.28	4.38	4.34	4.49	4.36	4.11	4.43	4.32	3.96	4.14	4.41	4.05	4.17	3.76	2.69	2.81	3.22	3.08	Hi Rzm
501	BTS 8337	4.64	4.36	4.62	4.50	4.54	3.74	3.78	3.26	3.76	3.59	4.07	4.30	4.08	4.18	4.15	4.18	3.83	4.01	4.00	4.01	Hi Rzm
577	BTS 8500	4.40	4.29	4.54	4.34	4.41	4.43	4.52	4.22	4.48	4.39	4.36	4.57	4.43	4.46	4.45	2.46	2.14	1.90	2.30	2.17	Hi Rzm
503	BTS 8524	4.50	4.38	4.74	4.44	4.54	4.08	4.49	3.89	4.28	4.15	4.23	4.41	4.20	4.32	4.28	3.93	3.24	3.38	3.59	3.52	Hi Rzm
576	BTS 8606	4.80	4.73	5.12	4.76	4.88	4.43	4.91	4.60	4.67	4.64	4.24	5.00	4.48	4.62	4.57	3.66	2.81	2.69	3.24	3.05	Hi Rzm
527	BTS 8629	4.52	4.29	4.59	4.40	4.46	3.89	4.68	4.14	4.28	4.24	4.02	4.21	3.73	4.12	3.99	4.40	4.20	4.04	4.30	4.21	Hi Rzm
530	Crystal 093RR	4.88	4.49	4.95	4.68	4.77	4.38	4.43	4.32	4.41	4.38	4.59	4.50	4.37	4.55	4.49	4.28	3.48	3.35	3.88	3.70	Hi Rzm
542	Crystal 247RR	4.54	4.55	4.65	4.55	4.58	5.02	5.35	4.77	5.19	5.05	4.56	4.49	4.32	4.52	4.46	3.34	3.00	2.80	3.17	3.05	Hi Rzm
562	Crystal 355RR	4.52	4.36	4.60	4.44	4.50	4.42	4.84	4.46	4.63	4.58	3.66	4.09	3.96	3.87	3.90	3.73	2.76	2.65	3.24	3.05	Hi Rzm
513	Crystal 467RR	4.61	4.46	4.69	4.53	4.58	3.68	3.96	4.04	3.82	3.90	3.94	4.47	4.26	4.21	4.23	2.92	1.98	1.84	2.45	2.25	Hi Rzm
518	Crystal 572RR	4.45	4.27	4.57	4.36	4.43	4.47	4.69	4.74	4.58	4.63	4.54	4.47	4.21	4.51	4.41	3.70	2.64	1.82	3.17	2.72	Hi Rzm
563	Crystal 573RR	4.38	4.15	4.35	4.26	4.29	4.33	3.84	4.06	4.09	4.08	4.29	4.57	4.55	4.43	4.47	4.20	3.10	3.49	3.65	3.60	Hi Rzm
575	Crystal 574RR	4.42	4.35	4.51	4.38	4.43	4.32	4.72	3.69	4.52	4.24	4.36	4.16	4.47	4.26	4.33	2.87	2.23	1.82	2.55	2.31	Hi Rzm
508	Crystal 578RR	4.74	4.91	4.87	4.83	4.84	4.21	4.56	4.44	4.38	4.40	4.30	4.40	4.32	4.35	4.34	3.36	2.41	1.99	2.88	2.59	Hi Rzm
580	Hilleshög HM4302RR	4.26	3.93	4.13	4.09	4.10	4.65	6.66	4.63	5.66	5.32	3.71	3.60	3.65	3.65	3.65	5.02	5.09	5.09	5.06	5.07	Rzm
510	Hilleshög HM4448RR	5.26	5.28	5.21	5.27	5.25	4.53	6.29	3.90	5.41	4.91	4.38	4.63	4.51	4.50	4.51	5.23	5.35	5.26	5.29	5.28	Rzm
543	Hilleshög HM9528RR	4.79	4.99	4.73	4.89	4.84	4.22	5.63	3.77	4.93	4.54	4.04	4.21	4.21	4.13	4.16	4.95	4.25	4.52	4.60	4.57	Hi Rzm
533	Hilleshög HIL9708	4.71	4.61	4.74	4.66	4.69	4.25	5.94	4.82	5.09	5.00	3.71	4.21	4.28	3.96	4.07	4.61	4.61	4.29	4.61	4.50	Hi Rzm
541	Maribo MA109	4.33	4.14	4.14	4.23	4.20	4.38	5.06	4.27	4.72	4.57	3.69	3.63	3.69	3.66	3.67	4.95	4.23	4.50	4.59	4.56	Hi Rzm
532	Maribo MA305	4.92	4.98	4.72	4.95	4.87	4.91	5.67	4.42	5.29	5.00	4.26	4.60	4.40	4.43	4.42	5.45	5.89	5.89	5.67	5.74	Rzm
515	Maribo MA502	4.95	5.01	4.79	4.98	4.92	3.67	3.53	3.06	3.60	3.42	4.20	4.78	4.73	4.49	4.57	3.33	3.02	1.92	3.17	2.76	Hi Rzm
504	Maribo MA504	4.98	5.50	5.04	5.24	5.17	5.30	6.20	4.54	5.75	5.34	4.25	4.37	4.58	4.31	4.40	4.80	4.52	4.60	4.66	4.64	Hi Rzm
552	SV RR265	4.48	5.19	5.00	4.83	4.89	4.16	5.35	4.54	4.76	4.69	4.32	4.42	4.44	4.37	4.39	5.44	5.32	5.26	5.38	5.34	Hi Rzm
540	SV RR266	4.73	4.61	4.74	4.67	4.69	4.72	5.64	4.62	5.18	4.99	4.34	4.39	4.20	4.36	4.31	5.73	5.64	5.18	5.69	5.52	Hi Rzm
548	SV RR268	4.70	5.06	5.13	4.88	4.97	4.21	4.71	4.00	4.46	4.31	4.21	4.57	4.70	4.39	4.49	5.12	5.01	5.20	5.06	5.11	Hi Rzm
537	SV RR333	4.78	4.84	4.85	4.81	4.82	4.06	4.99	4.71	4.52	4.59	4.23	4.44	4.44	4.34	4.37	5.14	5.35	4.84	5.24	5.11	Hi Rzm
544	SV RR351	4.61	4.41	4.50	4.51	4.51	4.50	4.18	4.38	4.34	4.35	4.16	4.25	4.17	4.20	4.19	5.30	4.96	4.75	5.13	5.00	Hi Rzm
573	SX Avalanche RR	4.50	4.64	4.74	4.57	4.63	4.18	4.00	4.44	4.09	4.21	4.36	4.29	4.52	4.33	4.39	5.37	5.75	5.38	5.56	5.50	Hi Rzm
569	SX Bronco RR(1863)	4.65	4.08	4.35	4.37	4.36	4.05	4.88	3.55	4.46	4.16	4.73	4.23	4.54	4.48	4.50	5.52	6.04	5.80	5.78	5.79	Hi Rzm
551	SX Canyon RR	4.79	4.92	4.76	4.85	4.82	4.34	4.33	4.28	4.33	4.32	4.36	4.51	4.40	4.43	4.42	4.93	5.12	5.26	5.03	5.10	Hi Rzm
549	SX Cruze RR	5.79	5.37	4.65	5.58	5.27	4.38	4.79	3.41	4.58	4.19	4.23	4.39	4.69	4.31	4.44	4.78	3.98	2.80	4.38	3.85	Rzm
528	SX Marathon RR	5.27	4.54	4.44	4.90	4.75	4.72	4.52	4.38	4.62	4.54	4.19	4.40	4.47	4.29	4.35	5.51	4.84	4.90	5.18	5.08	Hi Rzm
	ACSC Experimental																					
521	BTS 8735	4.21	4.22	--	4.22	--	4.00	4.74	--	4.37	--	4.12	4.38	--	4.25	--	4.04	3.93	--	3.98	--	Hi Rzm
512	BTS 8749	4.10	4.05	--	4.08	--	2.79	3.53	--	3.16	--	3.88	3.95	--	3.92	--	3.79	3.28	--	3.53	--	Hi Rzm
568	BTS 8767	4.32	4.16	--	4.24	--	4.28	4.80	--	4.54	--	4.10	4.75	--	4.42	--	3.41	2.71	--	3.06	--	Hi Rzm
572	BTS 8784	3.73	3.65	--	3.69	--	4.22	4.59	--	4.40	--	4.60	4.64	--	4.62	--	3.76	2.63	--	3.20	--	Hi Rzm
529	BTS 8815	4.65	--	--	--	--	3.97	--	--	--	--	3.88	--	--	--	--	3.64	--	--	--	--	Hi Rzm
505	BTS 8826	4.21	--	--	--	--	5.13	--	--	--	--	3.65	--	--	--	--	2.94	--	--	--	--	Hi Rzm
536	BTS 8839	4.41	--	--	--	--	3.74	--	--	--	--	4.15	--	--	--	--	3.67	--	--	--	--	Hi Rzm
516	BTS 8844	4.62	--	--	--	--	3.59	--	--	--	--	4.14	--	--	--	--	2.93	--	--	--	--	Hi Rzm
531	BTS 8857	4.36	--	--	--	--	5.02	--	--	--	--	4.14	--	--	--	--	5.28	--	--	--	--	Hi Rzm
554	BTS 8864	4.32	--	--	--	--	4.74	--	--	--	--	4.88	--	--	--	--	4.10	--	--	--	--	Hi Rzm
535	BTS 8882	4.53	--	--	--	--	4.98	--	--	--	--	4.37	--	--	--	--	3.39	--	--	--	--	Hi Rzm
553	BTS 8891	4.57	--	--	--	--	4.09	--	--	--	--	3.83	--	--	--	--	3.37	--	--	--	--	Hi Rzm
545	Crystal 684RR	4.41	4.34	4.57	4.38	4.44	3.83	4.31	3.74	4.07	3.96	4.39	4.57	4.41	4.48	4.46	2.96	2.01	1.76	2.49	2.25	Hi Rzm
522	Crystal 792RR	4.26	3.94	--	4.10	--	3.78	4.73	--	4.26	--	4.22	3.88	--	4.05	--	3.50	2.81	--	3.16	--	Hi Rzm
557	Crystal 793RR	4.26	3.93	--	4.10	--	3.32	3.02	--	3.17	--	4.11	4.26	--	4.18	--	3.59	2.95	--	3.27	--	Hi Rzm
574	Crystal 796RR	4.74	4.85	--	4.79	--	3.61	3.11	--	3.36	--	3.97	4.23	--	4.10	--	3.36	2.34	--	2.85	--	Hi Rzm
519	Crystal 802RR	4.46	--	--	--	--	3.95	--	--	--	--	4.31	--	--	--	--	3.57	--	--	--	--	Hi Rzm
558	Crystal 803RR	4.01	--	--	--	--	3.86	--	--	--	--	4.67	--	--	--	--	4.11	--	--	--	--	Hi Rzm
517	Crystal 804RR	4.42	--	--	--	--	3.58	--	--	--	--	4.02	--	--	--	--	3.05	--	--	--	--	Hi Rzm
550	Crystal 807RR	4.49	--	--	--	--	4.70	--	--	--	--	4.14	--	--	--	--	4.27	--	--	--	--	Hi Rzm
547	Crystal 808RR	4.86	--	--	--	--	3.60	--	--	--	--	3.83	--	--	--	--	3.12	--	--	--	--	Hi Rzm
534	Crystal 809RR	4.63	--	--	--	--	3.63	--	--	--	--	4.39	--	--	--	--	2.75	--	--	--	--	Hi Rzm
560	Hilleshög HIL2230	4.71	--	--	--	--	3.96	--	--	--	--	4.06	--	--	--	--	4.86	--	--	--	--	Hi Rzm
581	Hilleshög HIL2231	4.85	--	--	--	--	3.89	--	--	--	--	4.45	--	--	--	--	5.01	--	--	--	--	Hi Rzm
502	Hilleshög HIL2232	4.37	--	--	--	--	4.19	--	--	--	--	3.92	--	--	--	--	4.31	--	--	--	--	Hi Rzm
566	Hilleshög HIL2233	4.87	--	--	--	--	4.02	--	--	--	--	4.04	--	--	--	--	5.28	--	--	--	--	Hi Rzm
579	Hilleshög HIL2234	4.33	--	--	--	--	4.78	--	--	--	--	3.79	--	--	--	--	4.69	--	--	--	--	Hi Rzm
514	Hilleshög HIL2235	4.11	--	--	--	--	4.63	--	--	--	--	4.76	--	--	--	--	4.86	--	--	--	--	Hi Rzm
506	Hilleshög HIL2236	4.92	--	--	--	--	4.41	--	--	--	--	4.16	--	--	--	--	5.39	--	--	--	--	Hi Rzm
525	Hilleshög HIL9920	4.79	4.89	--	4.84	--	4.09	4.94	--	4.52	--	4.65	4.48	--	4.56	--	5.51	5.92	--	5.72	--	Hi Rzm
567	Maribo MA717	4.78	4.85	--	4.81	--	4.15	5.31	--	4.73	--	4.35	4.28	--	4.31	--	4.86	4.95	--	4.91	--	Hi Rzm
578	Maribo MA808	4.99	--	--	--	--	4.39	--	--	--	--	4.12	--	--	--	--	4.55	--	--	--	--	Hi Rzm
509	Maribo MA809	4.55	--	--	--	--	5.02	--	--	--	--	3.86	--	--	--	--	4.50	--	--	--	--	Hi Rzm
571	Maribo MA810	5.36	--	--	--	--	4.02	--	--	--	--	4.73	--	--	--	--	4.99	--	--	--	--	Hi Rzm

564	Maribo MA811	4.84	--	--	--	--	4.38	--	--	--	--	4.47	--	--	--	--	4.50	--	--	--	--	Hi Rzm
556	Maribo MA812	4.90	--	--	--	--	4.12	--	--	--	--	3.93	--	--	--	--	4.82	--	--	--	--	Hi Rzm
511	SV 284	4.07	--	--	--	--	4.48	--	--	--	--	4.18	--	--	--	--	4.71	--	--	--	--	Hi Rzm
561	SV 285	4.52	--	--	--	--	3.98	--	--	--	--	4.35	--	--	--	--	5.42	--	--	--	--	Hi Rzm
526	SV 286	5.25	--	--	--	--	4.77	--	--	--	--	4.44	--	--	--	--	5.06	--	--	--	--	Hi Rzm
520	SV 287	5.28	--	--	--	--	4.20	--	--	--	--	4.13	--	--	--	--	5.11	--	--	--	--	Hi Rzm
507	SV 288	4.88	--	--	--	--	5.39	--	--	--	--	4.23	--	--	--	--	4.51	--	--	--	--	Hi Rzm
523	SV 289	4.65	--	--	--	--	4.42	--	--	--	--	4.37	--	--	--	--	5.45	--	--	--	--	Hi Rzm
582	SV RR371	4.71	4.59	--	4.65	--	4.51	4.55	--	4.53	--	4.19	4.31	--	4.25	--	5.36	4.91	--	5.13	--	Hi Rzm
555	SV RR375	4.96	5.08	--	5.02	--	3.83	4.54	--	4.19	--	4.13	4.25	--	4.19	--	5.51	5.44	--	5.47	--	Hi Rzm
538	SX 1885	5.32	--	--	--	--	4.65	--	--	--	--	4.32	--	--	--	--	5.55	--	--	--	--	Hi Rzm
539	SX 1886	4.79	--	--	--	--	4.47	--	--	--	--	4.27	--	--	--	--	4.94	--	--	--	--	Hi Rzm
559	SX 1887	4.89	--	--	--	--	4.49	--	--	--	--	4.16	--	--	--	--	5.35	--	--	--	--	Hi Rzm
546	SX 1888	4.92	--	--	--	--	4.03	--	--	--	--	4.57	--	--	--	--	5.47	--	--	--	--	Hi Rzm
565	SX 1889	3.91	--	--	--	--	5.16	--	--	--	--	4.68	--	--	--	--	4.67	--	--	--	--	Hi Rzm
524	SX RR1879	4.44	4.88	--	4.66	--	4.39	4.18	--	4.28	--	4.32	4.36	--	4.34	--	5.18	4.64	--	4.91	--	Hi Rzm
	ACSC Conventional																					
910	BETA EXP 687	3.90	3.99	4.14	3.95	4.01	4.15	4.30	4.88	4.23	4.44	3.85	4.20	4.16	4.02	4.07	3.90	3.51	3.41	3.70	3.60	Hi Rzm
918	BETA EXP 698	4.18	4.18	4.27	4.18	4.21	3.68	3.62	3.69	3.65	3.66	4.22	4.45	4.35	4.34	4.34	3.25	3.06	2.74	3.16	3.02	Hi Rzm
919	BETA EXP 747	4.25	4.40	--	4.32	--	4.02	3.60	--	3.81	--	4.10	3.93	--	4.01	--	4.70	4.58	--	4.64	--	Hi Rzm
906	BETA EXP 758	4.22	4.52	--	4.37	--	3.70	3.29	--	3.50	--	3.98	4.31	--	4.14	--	4.20	3.91	--	4.06	--	Hi Rzm
907	BETA EXP 872	4.82	--	--	--	--	3.95	--	--	--	--	4.41	--	--	--	--	3.69	--	--	--	--	Hi Rzm
903	Crystal 620	4.30	4.14	4.19	4.22	4.21	3.79	4.09	4.28	3.94	4.05	4.15	4.37	4.54	4.26	4.35	3.47	2.79	2.73	3.13	3.00	Hi Rzm
904	Crystal 840	4.33	--	--	--	--	3.80	--	--	--	--	4.04	--	--	--	--	3.56	--	--	--	--	Hi Rzm
917	Crystal R761	4.72	4.93	4.99	4.82	4.88	4.09	4.01	3.57	4.05	3.89	4.36	4.54	4.57	4.45	4.49	4.11	3.23	3.25	3.67	3.53	Hi Rzm
912	Hilleshög HIL2243Rz	4.04	--	--	--	--	4.98	--	--	--	--	4.98	--	--	--	--	5.43	--	--	--	--	Hi Rzm
911	Hilleshög HM3035Rz	4.23	4.42	4.53	4.33	4.39	5.18	5.18	4.40	5.18	4.92	4.01	4.07	3.93	4.04	4.00	4.45	3.70	3.65	4.07	3.93	Rzm
909	Hilleshög 9891Rz	4.23	4.13	4.42	4.18	4.26	4.72	4.89	4.45	4.81	4.69	3.76	4.46	4.22	4.11	4.15	3.58	3.66	3.76	3.62	3.67	Rzm
901	Maribo MA615Rz	4.58	4.81	5.04	4.70	4.81	4.72	5.30	4.80	5.01	4.94	4.37	4.73	4.54	4.55	4.55	4.88	4.72	5.11	4.80	4.91	Rzm
914	Seedex 8869 Cnv	4.66	5.21	4.76	4.94	4.88	4.82	4.99	4.70	4.90	4.84	4.56	4.40	4.67	4.48	4.54	3.77	3.53	2.92	3.65	3.41	Hi Rzm
908	Seedex Deuce	4.74	4.76	4.68	4.75	4.73	5.26	6.04	5.70	5.65	5.67	4.53	4.39	4.66	4.46	4.52	5.04	4.54	4.68	4.79	4.75	Hi Rzm
920	Strube 12720	5.21	5.65	--	5.43	--	6.64	8.11	--	7.37	--	5.17	4.59	--	4.88	--	5.61	5.60	--	5.60	--	Rzm
905	Strube 12845	4.38	--	--	--	--	6.22	--	--	--	--	4.71	--	--	--	--	4.88	--	--	--	--	Rzm
913	Strube 12884	5.49	--	--	--	--	5.89	--	--	--	--	5.33	--	--	--	--	5.11	--	--	--	--	Rzm
915	Strube 13897	4.72	--	--	--	--	5.39	--	--	--	--	4.68	--	--	--	--	5.79	--	--	--	--	Rzm
902	SV 48611	4.95	5.28	4.85	5.12	5.03	4.60	4.25	4.47	4.43	4.44	4.54	4.35	4.66	4.44	4.52	5.67	5.74	5.24	5.70	5.55	Hi Rzm
916	SV 48777	4.56	4.76	--	4.66	--	5.13	4.20	--	4.66	--	4.49	4.59	--	4.54	--	4.45	3.96	--	4.21	--	Hi Rzm

CR ratings on a scale of 1-9. Green < 4.5, Red > 5.0

Created 11/5/2018

Aph root ratings on a scale of 1-9. Green < 4.4, Red > 5.5. Specialty level is 4.4.

Green highlighted ratings indicate specialty or good resistance.

Rhizoctonia ratings on a scale of 1-7. Green < 3.8, Red > 5.0. Specialty level is 3.82.

Red highlighted ratings indicate level of concern for some fields.

Fusarium ratings on a scale of 1-9. Green < 3.0, Red > 5.0

Hi Rzm = may perform better under severe Rzm.

Table 6. Planting & Harvest Dates, Previous Crop and Disease Levels for 2018 ACSC Official Trial Sites *

Location	District / Trial Type	Cooperator	Planting Date	Harvest Date	Preceeding Crop	Soil Type	Diseases Present @ Aph	Rhc	Rzm	Fus	Maggot	Rt Aphid	Comments
Casselton ND	Mhd/Hlb	Todd Weber	4/30	10/23	Wheat	Medium/Light	N	L-M	N	N	N	L	Wilting. RH in Conv
Glyndon MN	Mhd/Hlb	Menholt Farms	4/30	9/6	Wheat	Medium/Light	N	N	L-M	L-M	N	L	FS in Exp and Prop Trial
Georgetown MN	Mhd/Hlb	Hoff Farms	5/14	9/10	Soybeans	Medium	M-V	L-M	N	N	N	L	Severe AP (AP Specialty Site)
Ada MN	Mhd/Hlb	Ruebke Bros.	5/5	10/16	Wheat	Medium	N	L	M-V	N	N	L-V	RZ in all 4 Corners
Hillsboro ND	Mhd/Hlb	M&R Steenson Farms	5/7	9/13	Wheat	Medium	N	M	L-M	N	N	L	Severe RH in Part of Comm
Climax MN	EGF/Crk	Evenson Farms	5/6	9/11	Wheat	Medium	M-V	L-M	N	N	N	L-M	Light to Severe AP (AP Specialty Site)
Grand Forks ND	EGF/Crk	Drees Farming Association	5/15	9/24	Wheat	Medium/Light	N	L	L-M	N	L	N	Some Moderate Stands
Scandia MN	EGF/Crk	Dennis Deboer	5/3	10/18	Wheat	Medium	N	L	M	N	N	L-M	RA in all 4 Corners
East Grand Forks MN	EGF/Crk	Mark Holy	5/7	10/21	Wheat	Medium/Light	N	M	L	N	N	N	Light RH in Comm
Stephen MN	EGF/Crk	Jensen Farms	5/5	10/27	Barley	Medium	N	L	L	N	L	L	Some Brown Leaves
St Thomas ND	Dtn	Kennelly Farms	5/1	9/29	Wheat	Medium/Light	N	N	L	N	L	N	Lower Yield
Humboldt MN	Dtn	Youngren Farms	4/28	Abandon	Wheat	Medium/Heavy	N	L-M	N	N	L	M	Abandoned
Bathgate ND	Dtn	Shady Bend Farms	5/2	10/1	Wheat	Medium	N	N	N	N	L	N	Some Brown Leaves
Mhd Rhc-E	Rhc Nurs	Jon Hickel	5/16	7/14	Soybeans	Medium/Heavy	NA	V	NA	L	N	N	Heavy RH Infection
Mhd Rhc-W	Rhc Nurs	Jon Hickel	5/16	7/2	Soybeans	Medium/Heavy	NA	V	NA	L-M	N	N	Uniform RH Infection
NWROC Rhc	Rhc Nurs	Albert Sims	5/17	Abandon	Wheat	Medium	NA	L-M	N	N	N	N	Abandoned
BSDF Rhc	Rhc Nurs	Mitch McGrath	5/2	8/14	NA	NA	NA	V	NA	NA	NA	NA	Uniform RH Infection
Mhd SE Fus	Fusarium	Oberg Farms	6/22	7/18	Soybeans	Medium	NA	L	N	V	NA	NA	Replanted
Mhd Fus	Fusarium	Nelson Farms	5/12	7/26	Soybeans	Medium	NA	L	N	V	NA	NA	
Shakopee MN	Aph Nurs	Patrick O'Boyle	5/12	8/17	NA	NA	V	NA	NA	NA	NA	NA	
Longmont CO	RA Nurs	Kara Crist	6/30	9/20	NA	NA	NA	NA	NA	NA	NA	NA	Data Not Included
Foxhome CR	Cercospora	NDSU/Kevin Etzler	5/14	8/27	Soybeans	Medium	NA	L-M	NA	NA	NA	NA	Uniform CR Infection
BSDF CR	Cercospora	Mitch McGrath	5/1	9/6	NA	NA	NA	NA	NA	NA	NA	NA	Uniform CR Infection
Randolph MN CR	Cercospora	Patrick O'Boyle	5/5	8/9	NA	Medium/Light	NA	NA	NA	NA	NA	NA	Uniform CR Infection
													Created 10-31-2018

* Fertilizer applied in accordance to cooperative recommendations.

@ Disease notes for Aph., Rhizoc., Rhizomania, Fusarium, Root Maggot and Root Aphids were based upon visual evaluations (N=none, L=light, M=moderate, V=severe, NA=not observed)

Table 7. Seed Treatments Used on Approved Varieties in Official Variety Trials in 2018

Description	Years in Trial	Years ** Comm.	Fungicide (Rhizoctonia)	Insecticide ring Tails & Magg	achigaren Rat Aphanomyces	Priming (Emergence)	Fungicide (Damping Off)
ACSC Commercial							
BTS 80RR52	9	7	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8337	6	4	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8500	4	2	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8524	4	2	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8606	3	1	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8629	3	1	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
Crystal 093RR	9	7	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 247RR	7	5	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 355RR	6	3	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 467RR	5	1	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 572RR	4	2	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 573RR	4	1	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 574RR	4	2	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 578RR	4	1	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Hilleshög HM4302RR	8	5	Vibrance	Cruiser Maxx	45	XBEET	Apron XL Maxim
Hilleshög HM4448RR	7	5	Vibrance	Cruiser Maxx	45	XBEET	Apron XL Maxim
Hilleshög HM9528RR	6	4	Vibrance	NA	45	XBEET	Apron XL Maxim
Hilleshög HIL9708	4	1	Vibrance	Cruiser Maxx	45	XBEET	Apron XL Maxim
Maribo MA109	5	3	Vibrance	Cruiser Maxx	20	XBEET	Apron XL Maxim
Maribo MA305	6	3	Vibrance	Cruiser Maxx	20	XBEET	Apron XL Maxim
Maribo MA502	4	2	Vibrance	Cruiser Maxx	20	XBEET	Apron XL Maxim
Maribo MA504	4	2	Vibrance	Cruiser Maxx	20	XBEET	Apron XL Maxim
SX Avalanche RR	4	2	Metlock/Rizolex/Kabina	NipsIt	20	XBEET	Sebring Thiram
SX Bronco RR(1863	3	1	Metlock/Rizolex/Kabina	NipsIt	20	XBEET	Sebring Thiram
SX Canyon RR	5	3	Metlock/Rizolex/Kabina	NipsIt	20	XBEET	Sebring Thiram
SX Cruze RR	5	3	Metlock/Rizolex/Kabina	NipsIt	20	XBEET	Sebring Thiram
SX Marathon RR	4	2	Metlock/Rizolex/Kabina	NipsIt	20	XBEET	Sebring Thiram
SV RR265	3	1	Metlock/Rizolex/Vibrance	NipsIt	45	XBEET	Sebring Thiram
SV RR266	3	1	Metlock/Rizolex/Vibrance	NipsIt	45	XBEET	Sebring Thiram
SV RR268	3	1	Metlock/Rizolex/Vibrance	NipsIt	45	XBEET	Sebring Thiram
SV RR333	6	3	Metlock/Rizolex/Vibrance	NipsIt	45	XBEET	Sebring Thiram
SV RR351	4	2	Metlock/Rizolex/Vibrance	NipsIt	45	XBEET	Sebring Thiram
ACSC Experimental							
BTS 8735	2	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8749	2	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8767	2	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8784	2	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8815	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8826	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8839	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8844	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8857	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8864	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8882	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BTS 8891	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
Crystal 684RR	3	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 792RR	2	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 793RR	2	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 796RR	2	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 802RR	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 803RR	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 804RR	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 807RR	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 808RR	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 809RR	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Hilleshög HIL2230	1	NC	Vibrance	Poncho Beta	20	NA	Apron XL Maxim
Hilleshög HIL2231	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Hilleshög HIL2232	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Hilleshög HIL2233	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Hilleshög HIL2234	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Hilleshög HIL2235	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Hilleshög HIL2236	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Hilleshög HIL9920	2	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Maribo MA717	2	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim

Maribo MA808	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Maribo MA809	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Maribo MA810	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Maribo MA811	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Maribo MA812	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
SX 1885	1	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SX 1886	1	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SX 1887	1	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SX 1888	1	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SX 1889	1	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SX RR1879	2	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SV 284	1	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV 285	1	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV 286	1	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV 287	1	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV 288	1	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV 289	1	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV RR371	2	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
SV RR375	2	NC	Metlock/Rizolex/Vibrance	NipsIt	20	NA	Sebring Thiram
Conventional							
BETA EXP 687	3	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BETA EXP 698	3	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BETA EXP 747	2	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BETA EXP 758	2	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
BETA EXP 872	1	NC	Systiva	Poncho Beta	35	Ultipro	Allegiance Thiram
Crystal 620	3	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal 840	1	NC	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Crystal R761	12	9	Kabina	Poncho Beta	45	XBEET	Allegiance Thiram
Hilleshög HM3035Rz	14	12	Vibrance	Cruiser Maxx	45	NA	Apron XL Maxim
Hilleshög 9891Rz	3	2	Vibrance	Cruiser Maxx	45	NA	Apron XL Maxim
Hilleshög HIL2243Rz	1	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Maribo MA615Rz	3	NC	Vibrance	Cruiser Maxx	20	NA	Apron XL Maxim
Seedex 8869 Cnv	3	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
Seedex Deuce	11	NC	Metlock/Rizolex/Kabina	NipsIt	20	NA	Sebring Thiram
SV 48611	3	NC	Metlock/Rizolex/Vibrance	NipsIt	45	NA	Sebring Thiram
SV 48777	2	NC	Metlock/Rizolex/Vibrance	NipsIt	45	NA	Sebring Thiram
Strube 12720	2	NC	NA	Poncho Beta	14	3D Plus	Thiram
Strube 12845	1	NC	NA	Poncho Beta	14	3D Plus	Thiram
Strube 12884	1	NC	NA	Poncho Beta	14	3D Plus	Thiram
Strube 13897	1	NC	NA	Poncho Beta	14	3D Plus	Thiram
NA indicates no treatment applied in this category.							Created 11/5/201

Table 8. 2018 Performance of All RR Varieties - ACSC Official Trial

10 sites

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	346.5	100	9939	97	1.03	53.98	100	1536	97	18.36	28.94	167	1574	322	0	85.9
BTS 8337	119	356.8	103	10209	100	0.98	56.93	106	1619	102	18.81	28.83	155	1545	289	0	80.9
BTS 8500	124	343.7	99	11242	110	0.99	53.18	99	1719	108	18.18	33.16	175	1553	295	0	88.2
BTS 8524	127	333.6	96	11083	108	1.05	50.28	93	1658	105	17.72	33.49	196	1641	304	0	81.1
BTS 8606	106	349.8	101	10811	105	0.95	54.93	102	1684	106	18.44	31.19	161	1535	274	0	82.6
BTS 8629	110	343.2	99	11437	112	0.97	53.05	98	1752	111	18.13	33.69	187	1430	301	0	73.1
Crystal 093RR	126	356.0	103	10529	103	1.01	56.72	105	1666	105	18.81	29.83	149	1528	321	0	86.8
Crystal 247RR	113	345.4	100	10826	106	0.95	53.68	100	1669	105	18.21	31.60	189	1544	254	0	84.4
Crystal 355RR	109	350.1	101	9770	95	1.05	55.03	102	1524	96	18.56	28.13	172	1594	331	0	88.0
Crystal 467RR	120	340.9	98	10852	106	0.99	52.39	97	1653	104	18.04	32.15	216	1596	267	0	86.1
Crystal 572RR	112	354.6	102	10882	106	0.97	56.30	104	1718	108	18.70	30.91	146	1474	307	0	83.4
Crystal 573RR	101	354.3	102	10852	106	0.97	56.24	104	1711	108	18.68	30.89	154	1510	291	0	88.2
Crystal 574RR	114	342.5	99	11330	110	1.01	52.84	98	1733	109	18.14	33.40	177	1557	305	0	82.7
Crystal 578RR	115	346.5	100	10637	104	0.99	53.99	100	1645	104	18.31	30.97	177	1566	283	0	86.4
Hilleshög HM4302RR	107	343.8	99	10241	100	0.95	53.22	99	1572	99	18.14	30.07	196	1577	248	0	81.6
Hilleshög HM4448RR	125	346.8	100	11133	109	0.95	54.07	100	1720	109	18.29	32.45	161	1470	288	0	83.9
Hilleshög HM9528RR	117	344.5	99	10603	103	0.94	53.42	99	1632	103	18.17	31.07	174	1489	271	2	78.3
Hilleshög HIL9708	131	346.9	100	10848	106	0.95	54.10	100	1684	106	18.30	31.47	175	1493	276	0	85.3
Maribo MA109	128	354.3	102	9663	94	0.97	56.22	104	1522	96	18.68	27.53	176	1509	285	0	75.8
Maribo MA305	102	337.3	97	10549	103	0.94	51.36	95	1589	100	17.81	31.67	184	1459	275	0	76.1
Maribo MA502	116	335.4	97	10126	99	1.05	50.80	94	1520	96	17.82	30.52	232	1616	300	0	82.1
Maribo MA504	122	343.0	99	11406	111	0.99	52.98	98	1748	110	18.14	33.56	188	1538	291	0	84.4
SX Avalanche RR	129	348.8	101	10157	99	0.93	54.64	101	1582	100	18.37	29.33	169	1529	255	2	80.6
SX Bronco RR(1863)	105	349.0	101	10588	103	0.96	54.70	101	1647	104	18.41	30.58	173	1540	271	0	77.1
SX Canyon RR	103	346.0	100	10832	106	0.95	53.83	100	1674	106	18.25	31.58	159	1547	267	2	81.5
SX Cruze RR	121	319.5	92	10190	99	1.10	46.25	86	1465	92	17.08	32.14	203	1600	358	0	60.3
SX Marathon RR	111	347.2	100	11063	108	0.94	54.20	101	1717	108	18.30	32.08	149	1549	262	0	83.3
SV RR265	108	343.7	99	10824	106	0.93	53.20	99	1663	105	18.11	31.75	154	1522	259	0	83.6
SV RR266	118	345.5	100	10651	104	0.95	53.71	100	1644	104	18.22	31.08	158	1526	271	0	72.7
SV RR268	132	350.3	101	10767	105	0.96	55.08	102	1679	106	18.47	31.05	159	1548	271	0	80.6
SV RR333	123	351.1	101	10483	102	0.95	55.32	103	1642	104	18.50	30.04	158	1532	272	0	75.2
SV RR351	104	347.4	100	10715	104	0.93	54.24	101	1661	105	18.30	31.10	147	1546	258	0	78.6
Crystal 101RR (Check)	133	337.8	98	10591	103	1.07	51.49	95	1602	101	17.96	31.64	217	1693	297	0	83.5
BTS 8572 (Check)	134	350.7	101	10717	105	0.98	55.19	102	1677	106	18.51	30.77	145	1486	312	0	81.4
ACFILL #41	135	326.0	94	9641	94	0.93	48.12	89	1408	89	17.23	29.90	186	1498	257	0	83.1
ACFILL #42	136	332.3	96	9738	95	1.13	49.91	93	1448	91	17.74	29.65	233	1644	352	0	82.1

Experimental Trial (Comm status)																	
BTS 8735	250	354.1	102	10770	105	0.93	56.10	104	1689	107	18.63	30.77	177	1379	292	0	85.8
BTS 8749	243	347.6	100	10289	100	1.01	54.31	101	1596	101	18.40	29.85	166	1587	302	0	85.0
BTS 8767	225	344.7	100	10810	105	0.97	53.49	99	1664	105	18.21	31.63	174	1552	281	0	87.6
BTS 8784	210	358.0	103	10483	102	0.93	57.22	106	1667	105	18.82	29.42	134	1391	302	0	84.9
BTS 8815	211	351.1	101	10682	104	0.95	55.29	103	1670	105	18.51	30.66	174	1549	262	0	82.6
BTS 8826	245	352.1	102	9708	95	1.10	55.58	103	1522	96	18.70	27.72	179	1585	368	0	82.3
BTS 8839	232	354.4	102	10342	101	0.90	56.21	104	1627	103	18.62	29.44	151	1399	273	0	89.4
BTS 8844	205	353.9	102	10214	100	0.97	56.08	104	1608	101	18.66	29.07	180	1520	281	0	85.0
BTS 8857	235	349.9	101	9456	92	0.94	54.95	102	1472	93	18.44	27.33	142	1487	279	0	78.6
BTS 8864	224	356.1	103	10143	99	0.97	56.70	105	1605	101	18.77	28.65	140	1470	311	0	75.9
BTS 8882	229	345.3	100	11096	108	1.01	53.66	100	1709	108	18.27	32.42	183	1580	294	0	76.5
BTS 8891	226	356.3	103	10198	99	0.96	56.75	105	1612	102	18.78	28.86	151	1468	304	0	86.4
Crystal 684RR	227	342.3	99	11480	112	1.02	52.81	98	1756	111	18.13	33.86	194	1596	299	0	87.8
Crystal 792RR	240	349.9	101	10791	105	0.98	54.97	102	1684	106	18.48	31.04	153	1471	312	0	85.4
Crystal 793RR	238	356.7	103	11373	111	0.90	56.87	105	1804	114	18.74	32.05	143	1394	276	0	85.1
Crystal 796RR	231	345.4	100	11306	110	0.96	53.70	100	1743	110	18.24	33.04	159	1522	285	0	87.2
Crystal 802RR	207	353.3	102	10469	102	0.95	55.91	104	1647	104	18.61	29.80	151	1413	309	0	81.5
Crystal 803RR	244	352.2	102	11000	107	0.94	55.59	103	1727	109	18.55	31.41	158	1455	283	0	90.6
Crystal 804RR	246	343.5	99	11293	110	1.01	53.13	99	1731	109	18.18	33.20	196	1525	310	0	81.5
Crystal 807RR	215	347.9	100	10888	106	0.92	54.39	101	1692	107	18.32	31.45	194	1522	240	0	73.7
Crystal 808RR	218	347.8	100	11407	111	1.00	54.36	101	1771	112	18.39	33.03	191	1531	300	0	86.8
Crystal 809RR	214	350.6	101	10038	98	0.97	55.15	102	1566	99	18.50	28.86	178	1541	275	0	85.2
Hilleshög HIL2230	221	342.7	99	10295	100	0.97	52.91	98	1578	100	18.10	30.28	183	1474	294	0	86.1
Hilleshög HIL2231	208	334.3	97	9344	91	1.02	50.55	94	1398	88	17.73	28.28	221	1615	283	0	78.2
Hilleshög HIL2232	203	349.9	101	9924	97	1.00	54.97	102	1547	98	18.51	28.62	186	1538	302	0	85.1
Hilleshög HIL2233	209	351.4	101	10876	106	0.95	55.38	103	1705	108	18.52	31.13	164	1432	294	0	87.5
Hilleshög HIL2234	217	341.2	99	10172	99	0.96	52.52	97	1552	98	18.03	30.08	204	1538	262	0	85.8
Hilleshög HIL2235	247	342.9	99	10391	101	1.07	52.97	98	1592	100	18.21	30.57	200	1597	336	0	84.0
Hilleshög HIL2236	213	350.9	101	10030	98	0.94	55.23	102	1566	99	18.49	28.84	172	1437	286	0	87.9
Hilleshög HIL9920	223	355.2	103	10745	105	0.94	56.44	105	1695	107	18.69	30.47	171	1531	256	0	85.5
Maribo MA717	248	354.4	102	10573	103	0.96	56.21	104	1666	105	18.68	30.02	177	1486	290	0	87.2
Maribo MA808	234	337.7	98	9456	92	0.98	51.51	96	1430	90	17.87	28.29	222	1629	248	0	87.9
Maribo MA809	233	334.4	97	10632	104	1.00	50.59	94	1596	101	17.72	32.04	221	1610	270	0	83.4
Maribo MA810	220	343.8	99	9563	93	1.08	53.23	99	1467	93	18.26	28.05	199	1588	344	0	73.9
Maribo MA811	206	344.5	99	10237	100	1.02	53.41	99	1578	100	18.24	29.90	207	1589	296	0	73.0
Maribo MA812	222	351.6	102	9792	95	0.89	55.42	103	1532	97	18.48	28.08	153	1379	271	0	90.8
SX RR1879	219	347.1	100	10680	104	0.92	54.16	100	1652	104	18.28	31.09	151	1503	259	0	85.2
SX 1885	212	346.0	100	10397	101	0.98	53.87	100	1609	102	18.28	30.23	163	1532	290	0	76.7
SX 1886	239	345.3	100	10543	103	0.95	53.68	100	1628	103	18.21	30.71	152	1514	276	0	79.5
SX 1887	241	348.6	101	10658	104	0.95	54.58	101	1659	105	18.38	30.77	151	1556	265	0	78.6
SX 1888	216	349.3	101	10895	106	0.94	54.78	102	1698	107	18.40	31.40	143	1508	272	0	79.3
SX 1889	249	346.3	100	9671	94	0.95	53.93	100	1496	94	18.26	28.14	205	1523	256	0	88.0
SV 284	228	345.7	100	10249	100	0.94	53.78	100	1581	100	18.23	29.91	186	1505	263	0	86.2
SV 285	201	346.3	100	10563	103	0.94	53.94	100	1633	103	18.25	30.74	147	1513	269	0	82.0
SV 286	236	345.6	100	10419	102	0.96	53.74	100	1610	102	18.25	30.34	165	1491	293	0	73.4
SV 287	242	341.2	99	10578	103	0.98	52.51	97	1615	102	18.04	31.25	163	1571	282	0	83.6
SV 288	230	338.9	98	10623	104	0.97	51.83	96	1612	102	17.91	31.64	170	1531	283	0	82.7
SV 289	237	351.3	101	10789	105	0.94	55.33	103	1689	107	18.51	30.94	149	1527	269	0	81.5
SV RR371	202	346.0	100	10508	102	0.94	53.84	100	1622	102	18.24	30.60	154	1535	268	0	82.9
SV RR375	204	347.2	100	10625	104	0.94	54.18	100	1648	104	18.30	30.79	154	1520	272	0	84.6
BTS 80RR52(Check)	251	347.1	100	10084	98	1.06	54.17	100	1562	99	18.42	29.32	178	1593	333	0	85.7
Crystal 101RR (Check)	252	337.5	97	10542	103	1.08	51.45	95	1593	101	17.96	31.54	215	1724	303	0	85.5
Crystal 355RR(Check)	253	348.3	101	9969	97	1.05	54.48	101	1548	98	18.47	28.87	170	1573	339	0	87.4
BTS 8572 (Check)	254	352.2	102	10422	102	0.93	55.59	103	1636	103	18.55	29.76	137	1457	287	0	83.9
AP CHK MOD RES RR#4	255	347.2	100	10864	106	0.93	54.19	100	1681	106	18.29	31.62	177	1519	254	0	86.7
AP CHK SUS HYB#3	256	350.7	101	10000	98	0.99	55.19	102	1564	99	18.53	28.66	212	1515	292	0	81.4
Comm Benchmark Mean		346.3		10254		1.03	53.92		1585		18.35	29.87	175	1587	316		85.6
Comm Trial Mean		344.8		10609		0.98	53.49		1633		18.22	31.06	175	1543	287		81.4
Coeff. of Var. (%)		2.9		5.7		8.1	5.3		7.3		2.6	5.0	23	5.2	16		7.2
Mean LSD (0.05)		4.7		333		0.05	1.35		62		0.22	0.92	19	39	28		2.5
Mean LSD (0.01)		6.2		438		0.06	1.78		82		0.29	1.21	25	52	37		3.4
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from 10 sites — Bolters per acre are based upon 45,000 plants per acre. — Created 11/5/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 18ACSExp

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 9. 2018 Performance of Varieties - ACSC Experimental RR Official Trial Casselton ND																	
		Rec/T	Rec/T	Rec/A	Rec/A	Loss	Rev/T	Rev/T	Rev/A	Rev/A	Sugar	Yield	Na	K	AmN	Bolter	Emerg.
Description @	Code	lbs.	%Bnch	lbs.	%Bnch	Mol %	$ ++	%Bnch	$ ++	%Bnch	%	T/A	ppm	ppm	ppm	per Ac	%
Commercial Trial																	
BTS 80RR52	130	337.5	102	10526	95	1.12	51.41	103	1610	97	17.98	31.04	122	1670	376	0	84.3
BTS 8337	119	339.2	102	9874	89	1.12	51.90	104	1516	91	18.10	29.08	132	1800	350	0	82.8
BTS 8500	124	326.6	98	11606	104	1.14	48.28	97	1721	103	17.48	35.58	135	1725	376	0	89.5
BTS 8524	127	317.0	95	12261	110	1.18	45.55	91	1760	106	17.03	38.62	146	1700	413	0	85.9
BTS 8606	106	334.4	101	10861	98	1.03	50.51	101	1647	99	17.74	32.17	134	1755	293	0	85.3
BTS 8629	110	328.2	99	12484	112	1.09	48.76	98	1857	112	17.51	38.07	141	1640	360	0	78.5
Crystal 093RR	126	343.5	103	11284	101	1.15	53.13	106	1735	104	18.35	33.16	114	1740	389	0	88.6
Crystal 247RR	113	339.0	102	11834	106	1.04	51.83	104	1811	109	17.98	34.96	145	1801	271	0	86.2
Crystal 355RR	109	336.8	101	10919	98	1.27	51.22	103	1654	99	18.13	32.67	145	1883	432	0	92.8
Crystal 467RR	120	329.0	99	11580	104	1.17	48.96	98	1712	103	17.62	35.50	177	1867	341	0	84.5
Crystal 572RR	112	346.5	104	11298	102	1.10	53.99	108	1758	106	18.44	32.67	123	1663	375	0	83.9
Crystal 573RR	101	337.3	102	11516	104	1.07	51.37	103	1757	106	17.92	33.98	124	1725	325	0	90.4
Crystal 574RR	114	327.7	99	11669	105	1.13	48.61	97	1748	105	17.51	35.21	144	1798	349	0	83.2
Crystal 578RR	115	333.0	100	10903	98	1.16	50.11	100	1636	98	17.79	32.71	136	1813	361	0	86.3
Hilleshög HM4302RR	107	338.9	102	11153	100	1.06	51.81	104	1692	102	18.01	33.17	148	1870	274	0	87.3
Hilleshög HM4448RR	125	332.5	100	12221	110	1.06	49.97	100	1828	110	17.69	36.91	121	1593	361	0	84.4
Hilleshög HM9528RR	117	333.4	100	12210	110	1.03	50.22	101	1843	111	17.72	36.60	138	1710	299	0	82.8
Hilleshög HIL9708	131	337.0	101	12347	111	0.99	51.28	103	1903	114	17.85	36.27	140	1647	281	0	85.3
Maribo MA109	128	333.4	100	10509	94	1.00	50.24	101	1587	95	17.67	31.55	146	1639	284	0	77.1
Maribo MA305	102	314.4	95	11002	99	1.05	44.80	90	1591	96	16.77	34.70	167	1675	313	0	83.2
Maribo MA502	116	321.7	97	10920	98	1.25	46.88	94	1595	96	17.33	33.91	172	1883	406	0	83.3
Maribo MA504	122	328.0	99	12994	117	1.16	48.70	98	1925	116	17.56	39.76	153	1711	388	0	86.2
SX Avalanche RR	129	346.6	104	11061	99	1.06	54.03	108	1709	103	18.37	32.23	132	1710	310	0	83.5
SX Bronco RR(1863)	105	334.4	101	11603	104	1.09	50.53	101	1758	106	17.81	34.56	140	1789	325	0	81.5
SX Canyon RR	103	342.6	103	11517	104	1.10	52.88	106	1774	107	18.24	33.81	128	1798	326	0	83.6
SX Cruze RR	121	294.3	89	9728	87	1.34	39.03	78	1291	78	16.05	33.13	173	1817	493	0	58.2
SX Marathon RR	111	335.0	101	10693	96	1.05	50.71	102	1608	97	17.82	32.12	127	1825	286	0	89.2
SV RR265	108	340.5	102	11304	102	1.06	52.28	105	1730	104	18.07	33.19	122	1816	296	0	85.2
SV RR266	118	335.6	101	11534	104	1.05	50.86	102	1763	106	17.82	34.03	123	1798	293	0	76.4
SV RR268	132	335.4	101	11665	105	1.04	50.81	102	1775	107	17.79	34.66	119	1698	307	0	81.7
SV RR333	123	338.3	102	10986	99	1.17	51.63	103	1667	100	18.08	32.55	128	1832	368	0	77.9
SV RR351	104	336.2	101	11068	100	1.00	51.04	102	1671	100	17.82	33.03	132	1818	246	0	83.1
Crystal 101RR (Check)	133	316.2	95	11113	100	1.33	45.30	91	1583	95	17.13	35.32	175	2005	427	0	84.6
BTS 8572 (Check)	134	338.4	102	11925	107	1.03	51.68	104	1812	109	17.96	35.21	125	1674	322	0	85.5
ACFILL #41	135	314.8	95	10688	96	1.06	44.90	90	1524	92	16.81	33.90	155	1797	295	0	84.8
ACFILL #42	136	318.6	96	10583	95	1.25	45.99	92	1524	92	17.18	33.08	162	1903	408	0	85.1

Experimental Trial (Comm status)																	
BTS 8735	250	337.1	101	11899	107	0.97	51.25	103	1803	108	17.83	34.99	120	1552	288	0	86.6
BTS 8749	243	324.8	98	10339	93	1.24	47.84	96	1511	91	17.46	32.02	141	1803	427	0	84.1
BTS 8767	225	331.9	100	10808	97	1.14	49.81	100	1619	97	17.74	32.67	134	1671	388	0	90.9
BTS 8784	210	338.7	102	11320	102	1.12	51.69	104	1732	104	18.07	33.50	120	1615	399	0	83.6
BTS 8815	211	340.5	102	12092	109	1.05	52.18	105	1846	111	18.06	35.60	143	1707	301	0	82.7
BTS 8826	245	337.5	102	10858	98	1.28	51.35	103	1632	98	18.15	32.51	128	1794	469	0	83.2
BTS 8839	232	338.1	102	11238	101	0.99	51.51	103	1704	102	17.90	33.43	128	1543	305	0	91.3
BTS 8844	205	339.7	102	11018	99	1.07	51.96	104	1676	101	18.07	32.47	142	1705	321	0	87.0
BTS 8857	235	336.9	101	10401	94	1.15	51.20	103	1585	95	18.01	30.80	137	1789	368	0	72.9
BTS 8864	224	342.8	103	10635	96	1.14	52.82	106	1625	98	18.26	31.21	126	1610	404	0	71.9
BTS 8882	229	325.1	98	11455	103	1.18	47.92	96	1677	101	17.44	35.31	148	1776	390	0	78.4
BTS 8891	226	344.7	104	10891	98	1.11	53.35	107	1680	101	18.37	31.60	122	1667	372	0	87.4
Crystal 684RR	227	316.2	95	12242	110	1.23	45.48	91	1778	107	17.03	38.47	157	1815	411	0	88.2
Crystal 792RR	240	334.2	101	11750	106	1.11	50.46	101	1773	107	17.83	35.27	117	1613	393	0	89.4
Crystal 793RR	238	335.9	101	11137	100	1.09	50.90	102	1673	100	17.88	33.22	115	1542	393	0	89.1
Crystal 796RR	231	328.5	99	11914	107	1.12	48.88	98	1786	107	17.55	35.74	136	1669	376	0	80.7
Crystal 802RR	207	332.0	100	10239	92	1.14	49.82	100	1528	92	17.73	30.93	126	1647	400	0	86.1
Crystal 803RR	244	334.5	101	10766	97	1.05	50.52	101	1613	97	17.79	32.42	114	1551	355	0	95.1
Crystal 804RR	246	316.7	95	11720	105	1.19	45.60	91	1690	102	17.03	36.93	150	1763	400	0	81.8
Crystal 807RR	215	324.5	98	11516	104	1.06	47.75	96	1692	102	17.30	35.40	160	1787	281	0	80.5
Crystal 808RR	218	326.8	98	11990	108	1.26	48.41	97	1778	107	17.61	36.56	162	1752	448	0	88.2
Crystal 809RR	214	333.3	100	9812	88	1.07	50.20	101	1479	89	17.73	29.43	134	1705	320	0	82.1
Hilleshög HIL2230	221	319.1	96	10788	97	1.09	46.25	93	1558	94	17.06	33.61	161	1671	341	0	88.6
Hilleshög HIL2231	208	314.5	95	9814	88	1.16	45.00	90	1414	85	16.89	30.98	195	1822	343	0	80.2
Hilleshög HIL2232	203	325.3	98	10376	93	1.23	47.98	96	1533	92	17.50	31.54	175	1723	437	0	78.7
Hilleshög HIL2233	209	333.6	100	12280	110	1.04	50.30	101	1848	111	17.74	36.45	142	1602	321	0	93.2
Hilleshög HIL2234	217	325.9	98	11519	104	1.14	48.18	97	1692	102	17.43	35.51	156	1723	360	0	85.8
Hilleshög HIL2235	247	327.6	99	12413	112	1.22	48.61	97	1838	110	17.58	38.02	166	1771	418	0	86.0
Hilleshög HIL2236	213	341.1	103	10815	97	1.03	52.37	105	1659	100	18.11	31.76	126	1617	312	0	84.2
Hilleshög HIL9920	223	338.2	102	11778	106	1.11	51.54	103	1781	107	18.01	35.14	137	1761	332	0	86.7
Maribo MA717	248	337.8	102	11292	102	1.10	51.44	103	1713	103	17.98	33.65	144	1610	378	0	79.2
Maribo MA808	234	319.9	96	10830	97	1.10	46.50	93	1565	94	17.10	33.71	188	1897	278	0	80.0
Maribo MA809	233	328.0	99	11538	104	1.17	48.72	98	1694	102	17.58	35.55	169	1826	350	0	90.2
Maribo MA810	220	322.6	97	9623	87	1.24	47.23	95	1395	84	17.37	29.98	134	1519	515	0	81.4
Maribo MA811	206	325.0	98	11743	106	1.19	47.89	96	1722	103	17.45	36.05	159	1754	396	0	72.6
Maribo MA812	222	328.5	99	10576	95	0.96	48.88	98	1565	94	17.42	31.83	134	1538	285	0	93.3
SX RR1879	219	331.1	100	11894	107	1.02	49.61	99	1784	107	17.59	35.75	125	1736	277	0	78.9
SX 1885	212	325.5	98	11002	99	1.10	48.03	96	1613	97	17.38	34.02	131	1707	349	0	80.3
SX 1886	239	326.8	98	11449	103	1.06	48.39	97	1683	101	17.41	35.23	131	1647	333	0	84.8
SX 1887	241	331.1	100	10791	97	1.09	49.60	99	1613	97	17.64	32.77	130	1802	311	0	74.4
SX 1888	216	334.2	101	11536	104	1.12	50.45	101	1733	104	17.84	34.52	129	1764	351	0	77.9
SX 1889	249	334.9	101	11103	100	1.03	50.64	101	1680	101	17.79	33.24	144	1717	280	0	85.8
SV 284	228	332.3	100	12071	109	1.03	49.92	100	1806	108	17.66	36.65	133	1725	292	0	87.8
SV 285	201	329.2	99	10961	99	1.07	49.06	98	1633	98	17.53	33.58	121	1723	317	0	84.0
SV 286	236	331.0	100	11447	103	1.06	49.57	99	1716	103	17.61	34.28	116	1689	327	0	74.8
SV 287	242	316.9	95	10734	97	1.11	45.65	91	1550	93	16.95	33.79	141	1793	324	0	83.3
SV 288	230	325.9	98	11009	99	1.13	48.12	96	1620	97	17.44	33.69	143	1792	348	0	86.7
SV 289	237	338.2	102	11212	101	1.08	51.55	103	1685	101	17.98	33.54	119	1630	354	0	88.2
SV RR371	202	332.4	100	11006	99	1.06	49.94	100	1645	99	17.68	33.10	124	1731	310	0	82.4
SV RR375	204	332.9	100	11317	102	1.14	50.07	100	1700	102	17.77	34.10	128	1676	387	0	85.6
BTS 80RR52(Check)	251	334.5	101	10491	94	1.13	50.53	101	1588	95	17.85	31.39	132	1771	355	0	75.8
Crystal 101RR (Check)	252	316.2	95	11259	101	1.31	45.47	91	1615	97	17.13	35.57	183	2007	418	0	87.2
Crystal 355RR(Check)	253	342.5	103	11213	101	1.18	52.74	106	1722	103	18.31	32.76	128	1778	392	0	88.7
BTS 8572 (Check)	254	335.7	101	11520	104	1.13	50.86	102	1735	104	17.91	34.52	125	1676	390	0	80.8
AP CHK MOD RES RR	255	331.1	100	12960	117	1.07	49.61	99	1941	117	17.65	38.90	149	1679	318	0	87.4
AP CHK SUS HYB#3	256	339.0	102	11379	102	1.16	51.78	104	1728	104	18.12	33.92	161	1683	393	0	82.6
Comm Benchmark Mean		332.2		11121		1.19	49.90		1665		17.80	33.56	142	1808	389		83.1
Comm Trial Mean		331.7		11318		1.11	49.76		1696		17.70	34.14	140	1766	342		83.7
Coeff. of Var. (%)		2.5		6.7		9.3	4.9		7.9		2.3	6.1	13	7.9	20		7.6
Mean LSD (0.05)		11.0		1021		0.14	3.16		176		0.53	2.88	23	178	93		8.1
Mean LSD (0.01)		14.6		1350		0.19	4.17		232		0.70	3.80	31	234	123		10.7
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Casselton ND   Bolters per acre are based upon 45,000 plants per acre.   Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial.   Trial # = 188301

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 10. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

Glyndon MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	319.9	100	8200	98	1.05	46.38	100	1194	98	17.03	25.61	219	1413	352	0	81.8
BTS 8337	119	338.3	106	8936	106	0.99	51.63	111	1360	111	17.90	26.38	207	1414	314	0	79.9
BTS 8500	124	320.9	100	9510	113	1.04	46.66	100	1375	113	17.08	29.74	235	1400	347	0	86.1
BTS 8524	127	301.4	94	8618	103	1.11	41.07	88	1182	97	16.18	28.51	261	1511	362	0	79.9
BTS 8606	106	323.2	101	8539	102	1.00	47.31	102	1252	103	17.14	26.40	201	1408	324	0	74.0
BTS 8629	110	320.6	100	10167	121	1.09	46.58	100	1475	121	17.13	31.77	271	1342	386	0	68.0
Crystal 093RR	126	334.3	104	9194	109	1.00	50.49	109	1394	114	17.71	27.32	183	1382	343	0	78.1
Crystal 247RR	113	322.0	101	8950	107	1.02	46.96	101	1311	107	17.10	27.68	276	1392	315	0	78.2
Crystal 355RR	109	327.8	102	7921	94	1.03	48.64	105	1172	96	17.42	24.01	194	1439	344	0	75.5
Crystal 467RR	120	314.0	98	9341	111	1.06	44.68	96	1332	109	16.77	29.71	335	1352	339	0	83.1
Crystal 572RR	112	330.3	103	9209	110	0.94	49.36	106	1365	112	17.46	28.05	190	1287	320	0	75.5
Crystal 573RR	101	332.2	104	8763	104	0.93	49.88	107	1312	107	17.54	26.18	186	1368	292	0	84.6
Crystal 574RR	114	325.0	101	9769	116	1.02	47.83	103	1431	117	17.27	30.21	206	1442	337	0	77.4
Crystal 578RR	115	326.2	102	8469	101	0.97	48.16	104	1256	103	17.28	25.76	239	1383	297	0	78.8
Hilleshög HM4302RR	107	319.7	100	8670	103	0.99	46.32	100	1261	103	16.98	27.09	275	1386	293	0	73.8
Hilleshög HM4448RR	125	323.8	101	8930	106	0.95	47.49	102	1313	108	17.15	27.60	191	1327	313	0	72.2
Hilleshög HM9528RR	117	323.1	101	9717	116	0.94	47.27	102	1422	117	17.09	29.97	252	1320	288	0	79.9
Hilleshög HIL9708	131	310.2	97	8812	105	0.95	43.59	94	1237	101	16.47	28.28	246	1279	308	0	87.8
Maribo MA109	128	326.8	102	7829	93	0.96	48.35	104	1162	95	17.31	23.88	220	1349	306	0	67.9
Maribo MA305	102	309.5	97	9230	110	0.93	43.40	93	1296	106	16.41	29.84	235	1250	306	0	69.5
Maribo MA502	116	313.1	98	8980	107	0.99	44.43	96	1273	104	16.63	28.81	247	1375	306	0	71.1
Maribo MA504	122	317.7	99	8967	107	0.97	45.73	98	1300	107	16.87	28.08	238	1344	309	0	82.5
SX Avalanche RR	129	320.8	100	8545	102	0.94	46.62	100	1239	102	16.98	26.63	206	1331	300	0	78.0
SX Bronco RR(1863)	105	324.8	101	8949	106	1.00	47.77	103	1318	108	17.24	27.41	235	1366	326	0	76.1
SX Canyon RR	103	321.6	100	9315	111	0.91	46.84	101	1357	111	16.99	29.00	179	1375	276	0	78.1
SX Cruze RR	121	295.4	92	9293	111	1.10	39.35	85	1239	102	15.87	31.46	249	1477	374	0	56.1
SX Marathon RR	111	323.6	101	9484	113	0.91	47.43	102	1393	114	17.11	29.19	166	1413	273	0	81.7
SV RR265	108	331.4	103	9751	116	0.92	49.66	107	1452	119	17.49	29.64	162	1377	291	0	83.3
SV RR266	118	317.9	99	9045	108	0.94	45.79	99	1305	107	16.85	28.50	207	1338	299	0	65.2
SV RR268	132	326.8	102	9155	109	0.94	48.34	104	1359	111	17.29	28.11	189	1380	292	0	82.8
SV RR333	123	333.4	104	9136	109	0.87	50.25	108	1379	113	17.54	27.37	161	1326	267	0	70.9
SV RR351	104	329.7	103	9370	112	0.93	49.17	106	1395	114	17.42	28.43	163	1380	299	0	78.7
Crystal 101RR (Check)	133	311.8	97	8846	105	1.07	44.05	95	1255	103	16.65	28.37	246	1548	324	0	76.8
BTS 8572 (Check)	134	321.6	100	8647	103	1.00	46.86	101	1261	103	17.09	27.05	188	1350	348	0	76.3
ACFILL #41	135	307.7	96	7334	87	0.91	42.89	92	1019	83	16.29	23.91	217	1299	277	0	80.5
ACFILL #42	136	312.5	98	8390	100	1.03	44.25	95	1180	97	16.64	27.05	245	1408	335	0	74.5

Experimental Trial (Comm status)																	
BTS 8735	250	333.6	104	9518	113	1.13	50.19	108	1433	117	17.78	28.65	284	1271	431	0	84.8
BTS 8749	243	330.1	103	9083	108	1.04	49.22	106	1355	111	17.54	27.57	224	1443	334	0	83.2
BTS 8767	225	319.1	100	9679	115	1.09	46.15	99	1405	115	17.04	30.36	279	1462	349	0	82.0
BTS 8784	210	331.5	103	8561	102	0.96	49.60	107	1284	105	17.51	25.90	157	1229	352	0	90.2
BTS 8815	211	319.2	100	8511	101	1.06	46.18	99	1234	101	17.01	26.65	240	1467	335	0	80.5
BTS 8826	245	321.1	100	8443	100	1.24	46.71	100	1228	101	17.27	26.43	295	1465	468	0	82.0
BTS 8839	232	330.9	103	8970	107	0.95	49.44	106	1344	110	17.50	27.12	187	1323	310	0	89.1
BTS 8844	205	323.6	101	8341	99	1.05	47.40	102	1224	100	17.22	25.77	246	1359	355	0	77.7
BTS 8857	235	338.8	106	7853	93	0.94	51.64	111	1201	98	17.87	23.18	163	1344	308	0	82.0
BTS 8864	224	327.9	102	8492	101	1.00	48.60	105	1262	103	17.39	25.88	178	1298	354	0	80.9
BTS 8882	229	316.4	99	9386	112	1.08	45.38	98	1352	111	16.88	29.64	252	1439	351	0	77.4
BTS 8891	226	329.1	103	8712	104	0.96	48.93	105	1296	106	17.39	26.61	181	1295	335	0	87.9
Crystal 684RR	227	320.3	100	9872	117	1.05	46.47	100	1442	118	17.07	30.73	252	1396	340	0	90.2
Crystal 792RR	240	326.3	102	9433	112	1.05	48.16	104	1396	114	17.35	28.91	201	1273	389	0	88.3
Crystal 793RR	238	337.0	105	9903	118	0.92	51.14	110	1505	123	17.77	29.45	199	1251	308	0	86.3
Crystal 796RR	231	325.4	102	9374	112	1.02	47.90	103	1381	113	17.27	29.00	204	1357	348	0	88.3
Crystal 802RR	207	324.0	101	9058	108	1.04	47.52	102	1330	109	17.21	28.08	219	1258	382	0	76.6
Crystal 803RR	244	328.2	102	9190	109	0.99	48.67	105	1369	112	17.39	27.96	197	1326	340	0	87.5
Crystal 804RR	246	321.4	100	9496	113	1.07	46.78	101	1390	114	17.14	29.48	260	1378	362	0	87.9
Crystal 807RR	215	317.7	99	8760	104	1.03	45.78	98	1265	104	16.89	27.69	319	1308	327	0	75.0
Crystal 808RR	218	318.3	99	9608	114	1.05	45.94	99	1394	114	16.95	30.17	265	1339	349	0	91.4
Crystal 809RR	214	329.0	103	8471	101	0.99	48.88	105	1261	103	17.44	25.79	226	1320	323	0	77.0
Hilleshög HIL2230	221	309.3	97	8715	104	1.03	43.44	93	1222	100	16.46	28.40	304	1253	345	0	80.9
Hilleshög HIL2231	208	306.2	96	8090	96	1.08	42.58	92	1129	92	16.37	26.43	299	1404	346	0	78.5
Hilleshög HIL2232	203	323.4	101	8407	100	0.99	47.35	102	1231	101	17.17	25.93	234	1334	312	0	89.1
Hilleshög HIL2233	209	318.5	99	8867	106	1.09	45.98	99	1277	105	16.99	28.05	262	1269	404	0	91.8
Hilleshög HIL2234	217	313.1	98	8740	104	1.01	44.47	96	1250	102	16.66	27.85	261	1371	314	0	84.0
Hilleshög HIL2235	247	307.0	96	8901	106	1.11	42.79	92	1247	102	16.44	28.97	309	1335	376	0	85.9
Hilleshög HIL2236	213	323.1	101	8490	101	0.96	47.24	102	1246	102	17.09	26.32	262	1230	308	0	89.8
Hilleshög HIL9920	223	326.6	102	8968	107	0.93	48.25	104	1327	109	17.26	27.42	228	1338	266	0	84.4
Maribo MA717	248	329.4	103	8848	105	0.92	49.00	105	1317	108	17.37	26.86	212	1356	272	0	87.1
Maribo MA808	234	310.5	97	8408	100	1.01	43.76	94	1192	98	16.54	27.02	267	1395	301	0	90.6
Maribo MA809	233	306.7	96	9180	109	1.03	42.71	92	1285	105	16.36	29.84	285	1453	302	0	84.0
Maribo MA810	220	311.0	97	8178	97	1.12	43.89	94	1156	95	16.65	26.35	282	1386	390	0	71.1
Maribo MA811	206	307.1	96	8581	102	1.10	42.80	92	1200	98	16.44	27.99	294	1435	357	0	71.5
Maribo MA812	222	326.0	102	8031	96	0.92	48.07	103	1189	97	17.21	24.72	200	1204	316	0	93.8
SX RR1879	219	319.6	100	8864	105	0.96	46.28	100	1286	105	16.92	27.87	191	1375	306	0	87.5
SX 1885	212	321.8	100	9215	110	1.04	46.91	101	1346	110	17.12	28.69	201	1338	370	0	84.8
SX 1886	239	316.7	99	9198	109	0.98	45.47	98	1324	109	16.82	29.08	206	1305	324	0	80.1
SX 1887	241	321.6	100	9487	113	0.97	46.85	101	1385	113	17.05	29.45	176	1381	311	0	80.9
SX 1888	216	321.8	100	9207	110	0.97	46.89	101	1345	110	17.05	28.66	169	1313	338	0	82.8
SX 1889	249	320.8	100	8262	98	0.99	46.64	100	1206	99	17.02	25.77	265	1360	297	0	91.0
SV 284	228	319.5	100	8627	103	1.05	46.26	100	1254	103	17.02	26.96	266	1429	327	0	79.3
SV 285	201	322.1	101	9256	110	1.01	46.98	101	1357	111	17.09	28.88	198	1385	323	0	83.2
SV 286	236	310.5	97	8769	104	1.12	43.75	94	1238	101	16.62	28.31	235	1373	400	0	75.0
SV 287	242	322.9	101	9079	108	0.99	47.21	102	1331	109	17.12	28.22	186	1389	323	0	82.8
SV 288	230	303.5	95	9163	109	0.99	41.82	90	1267	104	16.15	30.23	203	1291	336	0	87.9
SV 289	237	329.6	103	9464	113	1.00	49.09	106	1413	116	17.46	28.90	199	1345	333	0	76.6
SV RR371	202	317.8	99	8823	105	0.95	45.81	99	1272	104	16.84	27.85	181	1396	299	0	80.9
SV RR375	204	321.2	100	9197	109	1.00	46.72	101	1342	110	17.06	28.57	194	1386	326	0	83.2
BTS 80RR52(Check)	251	319.7	100	8396	100	1.10	46.30	100	1218	100	17.07	26.33	214	1486	375	0	87.1
Crystal 101RR (Check)	252	311.9	97	8684	103	1.07	44.16	95	1230	101	16.66	27.83	249	1548	320	0	84.8
Crystal 355RR(Check)	253	322.1	101	8251	98	1.04	47.00	101	1206	99	17.15	25.58	214	1434	342	0	73.8
BTS 8572 (Check)	254	327.4	102	8283	99	0.95	48.47	104	1227	101	17.31	25.30	170	1282	331	0	80.9
AP CHK MOD RES RR	255	327.4	102	9242	110	1.04	48.47	104	1373	113	17.39	28.29	262	1434	308	0	84.0
AP CHK SUS HYB#3	256	318.4	99	7801	93	1.05	45.95	99	1127	92	16.94	24.57	300	1294	357	0	80.9
Comm Benchmark Mean		320.3		8404		1.04	46.48		1221		17.05	26.26	212	1438	342		81.6
Comm Trial Mean		321.1		8944		0.98	46.71		1301		17.04	27.86	220	1376	316		76.8
Coeff. of Var. (%)		3.4		5.6		7.8	6.7		8.1		3.0	4.4	24	5.1	12		8.9
Mean LSD (0.05)		13.2		624		0.10	3.79		129		0.61	1.56	64	85	50		8.1
Mean LSD (0.01)		17.5		824		0.13	5.01		170		0.81	2.06	84	113	66		10.7
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Glyndon MN — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188302

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

2018 Performance of Varieties - ACSC Experimental RR Official Trial
Georgetown MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	294.5	100	7503	99	1.43	39.09	101	997	99	16.17	25.50	230	1971	503	0	88.0
BTS 8337	119	306.0	104	7648	100	1.26	42.39	110	1057	105	16.56	25.05	210	1819	416	0	88.0
BTS 8500	124	288.7	98	8624	113	1.37	37.42	97	1124	112	15.80	29.79	247	1897	464	0	92.5
BTS 8524	127	283.3	97	8518	112	1.36	35.87	93	1068	106	15.52	30.22	239	1972	447	0	88.3
BTS 8606	106	288.2	98	7864	103	1.35	37.29	96	1019	102	15.77	27.24	251	1858	462	0	87.5
BTS 8629	110	288.9	99	8375	110	1.30	37.50	97	1085	108	15.74	29.02	242	1788	443	0	82.3
Crystal 093RR	126	296.5	101	7618	100	1.36	39.66	103	1017	101	16.19	25.74	216	1890	473	0	87.5
Crystal 247RR	113	281.8	96	7120	93	1.37	35.44	92	903	90	15.45	25.09	276	2011	428	0	93.5
Crystal 355RR	109	295.1	101	7356	97	1.40	39.26	101	975	97	16.15	25.03	228	1912	493	0	95.6
Crystal 467RR	120	283.6	97	8162	107	1.34	35.98	93	1030	103	15.52	28.82	304	1971	402	0	93.2
Crystal 572RR	112	303.1	103	8187	107	1.35	41.56	107	1117	111	16.50	27.14	197	1910	465	0	88.1
Crystal 573RR	101	307.2	105	7922	104	1.33	42.73	110	1105	110	16.70	25.70	215	1825	467	0	94.8
Crystal 574RR	114	286.3	98	8518	112	1.38	36.75	95	1097	109	15.70	29.67	254	1920	465	0	87.5
Crystal 578RR	115	292.8	100	7882	103	1.31	38.61	100	1039	104	15.96	26.97	243	1898	423	0	91.4
Hilleshög HM4302RR	107	295.6	101	6927	91	1.24	39.41	102	929	93	16.03	23.27	242	1854	384	0	82.0
Hilleshög HM4448RR	125	293.7	100	7905	104	1.25	38.87	100	1044	104	15.92	26.89	222	1795	413	0	92.7
Hilleshög HM9528RR	117	289.3	99	7994	105	1.20	37.59	97	1040	104	15.66	27.62	244	1743	380	0	91.5
Hilleshög HIL9708	131	295.7	101	6914	91	1.25	39.42	102	926	92	16.03	23.24	263	1818	387	0	91.9
Maribo MA109	128	303.2	103	6806	89	1.26	41.57	107	935	93	16.43	22.47	236	1799	416	0	82.0
Maribo MA305	102	287.3	98	7007	92	1.21	37.02	96	903	90	15.57	24.36	230	1770	386	0	81.5
Maribo MA502	116	296.4	101	7807	103	1.35	39.63	102	1046	104	16.17	26.26	272	1862	454	0	83.9
Maribo MA504	122	284.0	97	7239	95	1.34	36.07	93	926	92	15.53	25.30	283	1891	431	0	89.4
SX Avalanche RR	129	301.9	103	7206	95	1.30	41.22	107	984	98	16.39	23.85	265	1905	405	0	89.6
SX Bronco RR(1863)	105	299.8	102	7535	99	1.19	40.61	105	1021	102	16.19	25.15	247	1754	369	0	90.1
SX Canyon RR	103	295.4	101	7754	102	1.34	39.36	102	1036	103	16.11	26.19	228	1920	441	0	87.2
SX Cruze RR	121	270.8	92	7863	103	1.39	32.31	84	943	94	14.93	28.96	255	1862	487	0	77.3
SX Marathon RR	111	300.9	103	7569	99	1.32	40.93	106	1031	103	16.37	25.06	209	1945	433	0	89.9
SV RR265	108	302.4	103	8022	105	1.31	41.35	107	1100	110	16.43	26.49	206	1900	434	20	88.8
SV RR266	118	299.0	102	7345	96	1.26	40.39	104	994	99	16.22	24.53	217	1856	402	0	76.3
SV RR268	132	300.7	103	8033	105	1.25	40.87	106	1093	109	16.29	26.75	208	1866	393	0	91.6
SV RR333	123	298.5	102	7425	97	1.31	40.24	104	1001	100	16.23	24.88	233	1880	427	0	83.1
SV RR351	104	301.1	103	8014	105	1.26	40.97	106	1091	109	16.30	26.63	230	1847	402	0	82.8
Crystal 101RR (Check)	133	280.2	96	7776	102	1.48	34.99	90	972	97	15.49	27.74	289	2000	511	0	86.5
BTS 8572 (Check)	134	302.6	103	7830	103	1.35	41.41	107	1071	107	16.49	25.91	221	1864	473	0	87.2
ACFILL #41	135	278.8	95	7552	99	1.25	34.59	89	939	94	15.19	27.11	238	1800	402	0	89.9
ACFILL #42	136	290.1	99	8237	108	1.39	37.84	98	1076	107	15.90	28.41	266	1903	472	0	87.5

Experimental Trial (Comm status)																	
BTS 8735	250	290.4	99	7706	101	1.36	37.92	98	1005	100	15.89	26.62	231	1744	510	0	92.6
BTS 8749	243	291.5	99	7948	104	1.35	38.25	99	1039	103	15.95	27.37	264	1826	471	0	89.6
BTS 8767	225	281.7	96	7601	100	1.32	35.49	92	957	95	15.42	26.96	297	1854	431	0	85.9
BTS 8784	210	303.7	104	8089	106	1.37	41.65	108	1107	110	16.57	26.75	216	1766	523	0	91.4
BTS 8815	211	296.7	101	8352	110	1.29	39.69	103	1112	111	16.14	28.30	248	1823	432	0	87.1
BTS 8826	245	290.2	99	7440	98	1.56	37.86	98	968	96	16.08	25.70	230	1896	636	0	77.5
BTS 8839	232	296.4	101	8134	107	1.27	39.60	102	1090	109	16.10	27.52	248	1644	462	0	89.2
BTS 8844	205	303.7	104	8070	106	1.28	41.61	108	1106	110	16.47	26.66	272	1754	431	0	87.7
BTS 8857	235	299.0	102	6245	82	1.32	40.31	104	841	84	16.28	20.88	226	1963	422	0	82.2
BTS 8864	224	304.4	104	6976	92	1.41	41.83	108	959	96	16.63	22.87	198	1849	531	0	79.1
BTS 8882	229	281.7	96	8385	110	1.47	35.50	92	1055	105	15.55	29.80	300	1908	531	0	77.4
BTS 8891	226	304.7	104	7929	104	1.45	41.94	108	1085	108	16.69	26.15	257	1846	547	0	85.1
Crystal 684RR	227	286.6	98	8745	115	1.33	36.85	95	1124	112	15.66	30.62	252	1872	446	0	92.9
Crystal 792RR	240	299.5	102	8704	114	1.29	40.48	105	1180	118	16.28	29.07	201	1746	464	0	88.2
Crystal 793RR	238	297.6	102	8010	105	1.28	39.94	103	1072	107	16.18	27.01	241	1776	441	0	94.1
Crystal 796RR	231	290.4	99	8766	115	1.32	37.92	98	1142	114	15.85	30.28	246	1816	456	0	94.9
Crystal 802RR	207	301.2	103	8331	109	1.28	40.95	106	1125	112	16.35	27.85	206	1660	478	0	89.7
Crystal 803RR	244	300.3	102	8488	111	1.30	40.70	105	1150	115	16.33	28.35	232	1809	452	0	92.0
Crystal 804RR	246	282.5	96	8838	116	1.41	35.71	92	1116	111	15.53	31.41	264	1794	525	0	87.5
Crystal 807RR	215	290.7	99	8550	112	1.31	38.01	98	1115	111	15.86	29.43	276	1834	432	0	80.3
Crystal 808RR	218	292.3	100	8467	111	1.40	38.46	99	1109	110	16.02	29.03	279	1856	501	0	85.6
Crystal 809RR	214	293.9	100	7924	104	1.31	38.90	101	1049	105	16.01	27.02	280	1744	456	0	89.4
Hilleshög HIL2230	221	297.9	102	7794	102	1.28	40.00	103	1048	104	16.18	26.11	230	1734	447	0	90.4
Hilleshög HIL2231	208	289.2	99	6904	91	1.38	37.59	97	894	89	15.85	23.98	317	1887	461	0	84.9
Hilleshög HIL2232	203	292.3	100	6949	91	1.29	38.45	99	915	91	15.92	23.78	270	1838	413	0	90.8
Hilleshög HIL2233	209	303.4	104	7801	102	1.25	41.55	107	1069	107	16.44	25.70	244	1736	424	0	87.2
Hilleshög HIL2234	217	291.6	100	7083	93	1.31	38.28	99	930	93	15.90	24.32	269	1892	415	0	86.4
Hilleshög HIL2235	247	285.1	97	7121	93	1.47	36.46	94	911	91	15.73	25.05	314	1919	523	0	92.0
Hilleshög HIL2236	213	302.4	103	7164	94	1.22	41.26	107	975	97	16.35	23.84	233	1721	408	0	92.2
Hilleshög HIL9920	223	304.4	104	7565	99	1.24	41.85	108	1044	104	16.47	24.78	252	1836	379	0	89.0
Maribo MA717	248	303.5	104	7055	93	1.22	41.56	107	955	95	16.41	23.51	246	1711	406	0	92.4
Maribo MA808	234	287.8	98	7056	93	1.39	37.21	96	908	90	15.79	24.63	340	1923	447	0	88.9
Maribo MA809	233	282.8	97	7329	96	1.31	35.81	93	929	93	15.45	25.94	306	1850	414	0	86.6
Maribo MA810	220	291.6	100	6705	88	1.37	38.27	99	881	88	15.96	23.04	314	1781	483	0	78.6
Maribo MA811	206	300.8	103	8029	105	1.36	40.83	106	1083	108	16.42	26.82	272	1858	467	0	80.2
Maribo MA812	222	304.2	104	7075	93	1.17	41.78	108	971	97	16.40	23.26	215	1663	389	0	92.3
SX RR1879	219	291.3	99	7647	100	1.26	38.20	99	1005	100	15.84	26.26	225	1735	434	0	87.4
SX 1885	212	298.0	102	8005	105	1.28	40.05	104	1074	107	16.19	26.92	227	1865	415	0	78.1
SX 1886	239	295.2	101	7352	97	1.25	39.28	102	980	98	16.02	24.90	218	1808	408	0	85.4
SX 1887	241	296.0	101	7667	101	1.31	39.49	102	1024	102	16.12	25.94	232	1930	421	0	87.5
SX 1888	216	301.7	103	7804	102	1.24	41.07	106	1061	106	16.34	25.93	220	1827	395	0	86.0
SX 1889	249	293.8	100	6404	84	1.33	38.86	100	853	85	16.02	21.70	290	1855	438	0	88.7
SV 284	228	293.5	100	7190	94	1.36	38.79	100	945	94	16.04	24.62	280	1889	457	0	81.8
SV 285	201	300.5	103	7873	103	1.33	40.77	105	1067	106	16.37	26.26	251	1926	427	0	92.5
SV 286	236	292.9	100	7569	99	1.35	38.62	100	1000	100	16.00	25.80	246	1781	492	0	79.1
SV 287	242	295.1	101	7340	96	1.32	39.22	101	970	97	16.08	25.06	237	1840	449	0	83.2
SV 288	230	285.1	97	6777	89	1.40	36.46	94	867	86	15.66	23.80	266	1909	485	0	82.5
SV 289	237	294.6	101	7629	100	1.41	39.09	101	1012	101	16.15	25.89	241	1966	490	0	85.2
SV RR371	202	297.0	101	7360	97	1.32	39.77	103	977	97	16.18	24.96	254	1898	428	0	92.2
SV RR375	204	296.1	101	8098	106	1.36	39.54	102	1082	108	16.18	27.42	290	1837	470	0	89.6
BTS 80RR52(Check)	251	296.8	101	7396	97	1.40	39.72	103	987	98	16.25	24.99	232	1979	476	0	91.1
Crystal 101RR (Check)	252	281.7	96	7753	102	1.44	35.50	92	978	97	15.52	27.59	297	1983	482	0	88.3
Crystal 355RR(Check)	253	299.1	102	7783	102	1.41	40.36	104	1047	104	16.38	26.10	223	1916	506	0	94.1
BTS 8572 (Check)	254	294.9	101	7532	99	1.40	39.18	101	1003	100	16.15	25.49	217	1869	516	0	82.2
AP CHK MOD RES RR	255	266.4	91	6943	91	1.52	31.24	81	813	81	14.85	26.03	385	2044	509	0	91.3
AP CHK SUS HYB#3	256	291.1	99	6116	80	1.39	38.12	99	806	80	15.95	20.88	317	1892	467	0	83.1
Comm Benchmark Mean		293.1		7616		1.42	38.69		1004		16.08	26.05	242	1937	495		88.9
Comm Trial Mean		293.4		7724		1.32	38.78		1020		15.99	26.33	240	1874	435		87.8
Coeff. of Var. (%)		3.1		6.7		7.4	6.6		8.7		2.6	6.1	14	3.8	13		7.4
Mean LSD (0.05)		11.5		657		0.12	3.29		113		0.52	2.08	41	89	72		7.4
Mean LSD (0.01)		15.2		867		0.16	4.35		149		0.69	2.74	54	118	95		9.8
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Georgetown MN   Bolters per acre are based upon 45,000 plants per acre.   Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial.   Trial # = 188303

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 12. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

Ada MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	335.3	99	11043	95	0.83	50.78	98	1673	94	17.60	32.90	144	1384	226	0	92.5
BTS 8337	119	348.4	103	11760	101	0.75	54.54	105	1842	103	18.18	33.72	133	1342	181	0	88.3
BTS 8500	124	331.6	98	13424	115	0.79	49.73	96	2013	113	17.37	40.48	156	1372	191	0	92.1
BTS 8524	127	322.3	95	12793	110	0.86	47.06	91	1868	105	16.98	39.73	189	1449	216	0	90.6
BTS 8606	106	336.5	99	12315	106	0.75	51.12	99	1871	105	17.58	36.64	152	1298	182	0	91.7
BTS 8629	110	336.2	99	13873	119	0.72	51.05	99	2106	118	17.53	41.26	162	1228	175	0	81.8
Crystal 093RR	126	347.1	102	12308	106	0.82	54.15	105	1921	108	18.18	35.43	126	1346	234	0	93.4
Crystal 247RR	113	334.1	99	12679	109	0.76	50.43	97	1912	107	17.46	37.98	187	1317	168	0	94.3
Crystal 355RR	109	340.4	100	10325	89	0.84	52.23	101	1585	89	17.86	30.33	169	1369	225	0	94.3
Crystal 467RR	120	330.5	98	12554	108	0.75	49.40	95	1878	105	17.28	37.94	162	1362	162	0	94.3
Crystal 572RR	112	346.5	102	12725	109	0.77	53.98	104	1983	111	18.09	36.71	133	1284	206	0	95.7
Crystal 573RR	101	343.2	101	13182	113	0.74	53.05	102	2037	114	17.90	38.40	137	1302	179	0	96.0
Crystal 574RR	114	332.4	98	13591	117	0.80	49.96	96	2045	115	17.42	40.83	153	1346	205	0	92.3
Crystal 578RR	115	339.1	100	12642	108	0.75	51.87	100	1934	108	17.71	37.35	148	1313	180	0	96.6
Hilleshög HM4302RR	107	329.4	97	11457	98	0.75	49.10	95	1708	96	17.23	34.83	182	1350	159	0	89.8
Hilleshög HM4448RR	125	327.7	97	12976	111	0.73	48.60	94	1925	108	17.12	39.56	166	1258	175	0	94.4
Hilleshög HM9528RR	117	324.9	96	12581	108	0.71	47.80	92	1847	104	16.96	38.73	161	1220	168	0	87.1
Hilleshög HIL9708	131	330.5	98	12545	108	0.76	49.42	95	1875	105	17.28	38.00	199	1288	172	0	90.4
Maribo MA109	128	342.5	101	11240	96	0.71	52.86	102	1734	97	17.84	32.79	138	1245	173	0	84.6
Maribo MA305	102	323.2	95	12469	107	0.69	47.32	91	1826	102	16.85	38.60	157	1191	164	0	86.3
Maribo MA502	116	324.7	96	12003	103	0.82	47.73	92	1767	99	17.06	36.90	233	1373	186	0	93.8
Maribo MA504	122	325.7	96	13726	118	0.74	48.03	93	2024	114	17.02	42.14	182	1284	164	0	91.2
SX Avalanche RR	129	336.9	99	11359	97	0.74	51.23	99	1724	97	17.58	33.78	157	1269	176	0	89.2
SX Bronco RR(1863)	105	333.5	98	12273	105	0.73	50.25	97	1851	104	17.40	36.76	179	1256	164	0	83.8
SX Canyon RR	103	325.7	96	12699	109	0.71	48.03	93	1873	105	17.00	38.98	150	1229	168	0	88.1
SX Cruze RR	121	310.4	92	12287	105	0.78	43.63	84	1728	97	16.30	39.56	213	1238	199	0	73.2
SX Marathon RR	111	334.0	99	12948	111	0.67	50.40	97	1954	110	17.37	38.81	112	1241	152	0	92.7
SV RR265	108	327.0	97	12504	107	0.68	48.41	93	1850	104	17.02	38.24	146	1193	155	0	91.6
SV RR266	118	331.7	98	12569	108	0.71	49.75	96	1887	106	17.29	37.87	153	1258	160	0	78.3
SV RR268	132	337.8	100	12703	109	0.74	51.50	99	1937	109	17.63	37.63	148	1310	174	0	87.9
SV RR333	123	336.9	99	12383	106	0.73	51.23	99	1883	106	17.57	36.73	150	1263	177	0	80.0
SV RR351	104	328.1	97	12583	108	0.72	48.70	94	1868	105	17.12	38.35	140	1259	174	0	84.4
Crystal 101RR (Check)	133	332.0	98	12262	105	0.86	49.83	96	1841	103	17.46	36.96	210	1460	201	0	93.5
BTS 8572 (Check)	134	347.7	103	13002	112	0.76	54.33	105	2032	114	18.15	37.36	126	1283	208	0	90.3
ACFILL #41	135	305.0	90	10736	92	0.78	42.09	81	1482	83	16.03	35.22	223	1289	183	0	91.2
ACFILL #42	136	307.1	91	10941	94	0.88	42.70	82	1521	85	16.24	35.66	244	1404	223	0	89.4

Experimental Trial (Comm status)																	
BTS 8735	250	340.4	100	12324	106	0.73	52.24	101	1889	106	17.76	36.11	144	1173	211	0	93.7
BTS 8749	243	338.8	100	11421	98	0.76	51.78	100	1744	98	17.69	34.11	171	1355	165	0	95.3
BTS 8767	225	336.0	99	11468	98	0.76	50.99	98	1737	97	17.56	34.54	164	1370	159	0	93.8
BTS 8784	210	347.7	103	11684	100	0.76	54.27	105	1840	103	18.15	33.53	135	1232	213	0	93.8
BTS 8815	211	340.4	100	11707	100	0.77	52.22	101	1802	101	17.78	34.52	169	1354	169	0	88.3
BTS 8826	245	347.1	102	11066	95	0.81	54.11	104	1743	98	18.16	31.65	141	1353	219	0	89.9
BTS 8839	232	342.0	101	11392	98	0.70	52.67	102	1746	98	17.80	33.56	135	1173	182	0	94.9
BTS 8844	205	349.1	103	11106	95	0.74	54.66	106	1751	98	18.19	31.77	152	1304	171	0	94.9
BTS 8857	235	331.1	98	10315	88	0.79	49.62	96	1543	87	17.34	31.27	150	1314	205	0	89.4
BTS 8864	224	349.2	103	12564	108	0.77	54.69	106	1984	111	18.22	35.44	132	1278	205	0	81.7
BTS 8882	229	334.1	99	11894	102	0.80	50.46	97	1798	101	17.50	35.85	162	1362	194	0	83.6
BTS 8891	226	340.7	101	10620	91	0.79	52.30	101	1614	91	17.82	31.72	163	1265	215	0	94.1
Crystal 684RR	227	337.3	100	13263	114	0.82	51.34	99	2022	113	17.67	38.87	191	1368	205	0	94.9
Crystal 792RR	240	345.1	102	12048	103	0.74	53.54	103	1878	105	18.00	34.94	137	1278	186	0	94.9
Crystal 793RR	238	346.0	102	12784	110	0.71	53.79	104	1957	110	18.02	37.28	139	1244	173	0	98.4
Crystal 796RR	231	332.4	98	12216	105	0.81	49.97	96	1826	102	17.43	36.94	148	1360	210	0	92.6
Crystal 802RR	207	345.2	102	12167	104	0.73	53.56	103	1876	105	18.01	35.35	142	1225	198	0	90.6
Crystal 803RR	244	345.9	102	12797	110	0.72	53.77	104	2004	112	18.02	36.77	137	1236	182	0	98.9
Crystal 804RR	246	334.4	99	13055	112	0.77	50.55	98	1964	110	17.50	38.83	162	1343	175	0	90.3
Crystal 807RR	215	334.0	99	12203	105	0.79	50.45	97	1868	105	17.50	35.74	214	1348	176	0	78.1
Crystal 808RR	218	337.9	100	13199	113	0.79	51.54	100	1993	112	17.67	39.02	167	1347	185	0	91.0
Crystal 809RR	214	340.5	100	11421	98	0.76	52.26	101	1772	99	17.80	33.06	162	1351	171	0	98.1
Hilleshög HIL2230	221	327.7	97	11070	95	0.73	48.65	94	1648	92	17.13	34.05	174	1259	175	0	91.0
Hilleshög HIL2231	208	310.8	92	10043	86	0.76	43.90	85	1416	79	16.28	32.26	239	1270	161	0	86.3
Hilleshög HIL2232	203	325.2	96	10678	92	0.69	47.96	93	1561	88	16.95	32.81	157	1251	145	0	90.2
Hilleshög HIL2233	209	341.8	101	12280	105	0.70	52.60	102	1891	106	17.79	36.03	145	1246	160	0	91.8
Hilleshög HIL2234	217	325.2	96	11027	95	0.76	47.96	93	1632	92	17.02	33.87	216	1329	152	0	93.4
Hilleshög HIL2235	247	329.2	97	11872	102	0.84	49.07	95	1758	99	17.28	36.11	207	1396	201	0	92.5
Hilleshög HIL2236	213	328.3	97	10966	94	0.70	48.83	94	1642	92	17.12	33.15	168	1194	170	0	95.7
Hilleshög HIL9920	223	337.9	100	11837	102	0.74	51.55	100	1793	101	17.65	35.16	174	1304	169	0	90.3
Maribo MA717	248	338.1	100	11635	100	0.70	51.60	100	1767	99	17.61	34.38	153	1253	155	0	95.7
Maribo MA808	234	321.6	95	10332	89	0.73	46.96	91	1511	85	16.81	31.99	225	1275	149	6	96.5
Maribo MA809	233	318.6	94	11442	98	0.77	46.09	89	1661	93	16.69	35.75	207	1348	161	0	94.1
Maribo MA810	220	335.6	99	11070	95	0.79	50.88	98	1687	95	17.58	32.93	168	1390	182	0	85.9
Maribo MA811	206	331.8	98	10755	92	0.83	49.80	96	1613	90	17.42	32.42	233	1390	190	0	85.2
Maribo MA812	222	331.0	98	10955	94	0.72	49.59	96	1656	93	17.28	33.02	167	1200	183	0	90.3
SX RR1879	219	331.1	98	11479	98	0.73	49.62	96	1712	96	17.29	34.88	164	1240	183	0	85.6
SX 1885	212	334.5	99	11432	98	0.71	50.57	98	1748	98	17.44	34.00	155	1250	163	0	82.8
SX 1886	239	341.0	101	12256	105	0.68	52.39	101	1888	106	17.74	35.78	126	1243	152	0	81.3
SX 1887	241	339.5	100	12271	105	0.69	51.97	100	1862	104	17.66	36.25	127	1312	137	0	80.1
SX 1888	216	339.0	100	12364	106	0.69	51.83	100	1883	106	17.65	36.63	142	1269	150	0	82.0
SX 1889	249	334.4	99	10276	88	0.74	50.55	98	1538	86	17.47	31.00	170	1250	186	0	94.1
SV 284	228	334.3	99	11345	97	0.78	50.53	98	1729	97	17.50	33.86	188	1331	183	0	94.9
SV 285	201	329.0	97	11337	97	0.65	49.02	95	1693	95	17.11	34.36	144	1160	141	0	89.5
SV 286	236	331.8	98	11706	100	0.73	49.80	96	1768	99	17.32	35.21	157	1227	188	0	77.8
SV 287	242	336.2	99	12325	106	0.74	51.06	99	1875	105	17.55	36.39	146	1329	166	0	91.8
SV 288	230	324.9	96	11899	102	0.71	47.87	92	1754	98	16.96	36.52	157	1259	165	0	89.0
SV 289	237	333.9	99	11772	101	0.73	50.42	97	1773	99	17.44	35.26	130	1272	181	0	86.3
SV RR371	202	333.6	98	11801	101	0.73	50.32	97	1762	99	17.42	35.57	136	1302	172	0	91.8
SV RR375	204	340.6	101	12105	104	0.71	52.28	101	1868	105	17.74	35.31	133	1297	158	0	89.0
BTS 80RR52(Check)	251	346.2	102	11920	102	0.83	53.83	104	1852	104	18.13	34.28	143	1360	228	0	95.3
Crystal 101RR (Check)	252	325.2	96	12077	104	0.87	47.98	93	1781	100	17.15	37.13	216	1472	208	0	90.6
Crystal 355RR(Check)	253	342.1	101	11096	95	0.86	52.73	102	1715	96	17.97	32.40	157	1395	239	0	96.4
BTS 8572 (Check)	254	341.9	101	11539	99	0.73	52.63	102	1783	100	17.83	33.73	133	1269	183	0	92.2
AP CHK MOD RES RR	255	337.8	100	12080	104	0.71	51.47	99	1858	104	17.61	35.60	159	1287	155	0	94.6
AP CHK SUS HYB#3	256	342.1	101	11333	97	0.80	52.72	102	1743	98	17.90	33.20	195	1313	198	0	87.1
Comm Benchmark Mean		338.9		11658		0.82	51.79		1783		17.77	34.39	162	1374	215		93.6
Comm Trial Mean		331.8		12374		0.76	49.79		1856		17.35	37.31	164	1302	183		89.6
Coeff. of Var. (%)		3.2		5.8		6.9	6.2		7.9		3.1	4.7	26	5.1	12		4.5
Mean LSD (0.05)		12.4		813		0.06	3.54		166		0.61	2.03	51	77	26		4.7
Mean LSD (0.01)		16.3		1072		0.08	4.67		219		0.80	2.68	67	102	34		6.2
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Ada MN — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188304

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 13. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

Hillsboro ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	353.1	102	10934	101	1.05	55.89	104	1722	102	18.70	31.20	158	1680	309	0	93.0
BTS 8337	119	352.1	102	10686	98	0.99	55.61	103	1691	101	18.59	30.20	152	1662	268	0	88.8
BTS 8500	124	333.0	96	11700	108	1.02	50.13	93	1764	105	17.68	35.05	170	1669	286	0	95.9
BTS 8524	127	336.8	97	11699	108	1.01	51.20	95	1770	105	17.85	34.89	165	1699	275	0	86.2
BTS 8606	106	348.1	101	11626	107	0.99	54.46	101	1820	108	18.40	33.40	163	1649	269	0	89.3
BTS 8629	110	337.7	98	11660	107	0.96	51.47	96	1781	106	17.85	34.40	171	1571	266	0	77.9
Crystal 093RR	126	358.1	104	10812	100	1.02	57.31	107	1729	103	18.93	30.35	141	1606	317	0	93.3
Crystal 247RR	113	328.4	95	10397	96	1.02	48.81	91	1541	92	17.44	31.74	202	1708	264	0	91.7
Crystal 355RR	109	347.8	101	10548	97	1.05	54.37	101	1647	98	18.44	30.25	149	1687	311	0	93.7
Crystal 467RR	120	335.5	97	11134	103	1.00	50.82	94	1684	100	17.78	33.25	188	1673	265	0	94.0
Crystal 572RR	112	348.2	101	11363	105	1.02	54.48	101	1781	106	18.42	32.55	137	1585	314	0	91.9
Crystal 573RR	101	356.2	103	11046	102	1.01	56.77	106	1762	105	18.82	30.98	136	1643	292	0	94.0
Crystal 574RR	114	339.5	98	11750	108	1.02	51.99	97	1802	107	18.00	34.57	145	1636	302	0	90.9
Crystal 578RR	115	333.8	97	10771	99	1.00	50.35	94	1625	97	17.69	32.30	192	1661	263	0	92.7
Hilleshög HM4302RR	107	341.7	99	10905	101	0.96	52.63	98	1673	99	18.04	31.93	168	1646	242	0	89.8
Hilleshög HM4448RR	125	328.9	95	10712	99	1.02	48.94	91	1592	95	17.46	32.63	178	1618	297	0	89.8
Hilleshög HM9528RR	117	336.0	97	10694	99	1.00	50.98	95	1623	96	17.80	31.85	173	1623	284	0	86.8
Hilleshög HIL9708	131	341.6	99	11292	104	0.99	52.57	98	1743	104	18.07	33.01	162	1596	285	0	90.7
Maribo MA109	128	350.3	101	9966	92	1.05	55.08	102	1565	93	18.56	28.49	191	1643	309	0	82.3
Maribo MA305	102	319.4	92	10320	95	1.02	46.21	86	1495	89	16.99	32.24	185	1613	291	0	81.8
Maribo MA502	116	330.6	96	10617	98	1.08	49.43	92	1590	95	17.61	32.11	210	1730	297	0	90.3
Maribo MA504	122	338.0	98	11448	106	0.98	51.56	96	1749	104	17.89	33.86	171	1601	273	0	89.6
SX Avalanche RR	129	337.7	98	10183	94	0.99	51.46	96	1553	92	17.87	30.21	193	1653	258	0	86.5
SX Bronco RR(1863)	105	349.2	101	11194	103	0.93	54.75	102	1751	104	18.39	32.02	165	1611	235	0	80.0
SX Canyon RR	103	335.7	97	10999	101	0.98	50.89	95	1664	99	17.76	32.78	160	1647	261	0	85.7
SX Cruze RR	121	315.8	91	10885	100	1.08	45.20	84	1556	92	16.87	34.39	170	1700	322	0	67.7
SX Marathon RR	111	345.9	100	11770	108	0.96	53.81	100	1827	109	18.25	34.08	147	1684	242	0	87.0
SV RR265	108	338.7	98	11163	103	0.92	51.76	96	1705	101	17.86	32.99	134	1631	236	0	89.3
SV RR266	118	343.6	99	11202	103	0.93	53.16	99	1728	103	18.10	32.74	138	1607	244	0	78.1
SV RR268	132	349.6	101	11086	102	0.98	54.88	102	1738	103	18.46	31.81	147	1697	258	0	88.5
SV RR333	123	347.1	100	10693	99	1.01	54.16	101	1667	99	18.36	30.81	177	1652	278	0	81.7
SV RR351	104	333.8	97	10438	96	0.94	50.35	94	1579	94	17.63	31.25	145	1606	248	0	85.7
Crystal 101RR (Check)	133	341.9	99	11178	103	1.05	52.67	98	1717	102	18.15	32.87	201	1752	283	0	89.9
BTS 8572 (Check)	134	340.5	98	10740	99	1.04	52.27	97	1643	98	18.06	31.65	163	1609	323	0	89.0
ACFILL #41	135	311.4	90	9851	91	0.98	43.92	82	1391	83	16.56	31.67	183	1618	268	0	89.1
ACFILL #42	136	339.1	98	10348	95	1.03	51.87	96	1582	94	17.99	30.56	171	1661	296	0	89.6

Experimental Trial (Comm status)																	
BTS 8735	250	360.3	104	11434	105	0.96	57.93	108	1825	108	18.97	32.03	159	1530	283	0	95.0
BTS 8749	243	341.3	99	10802	100	1.09	52.52	98	1667	99	18.15	31.60	156	1800	303	0	85.4
BTS 8767	225	346.5	100	11420	105	1.00	54.00	100	1769	105	18.33	32.96	168	1649	282	0	94.0
BTS 8784	210	360.5	104	10856	100	0.95	57.96	108	1737	103	18.96	30.24	165	1447	296	0	87.8
BTS 8815	211	351.7	102	11182	103	1.01	55.49	103	1756	104	18.59	32.01	192	1649	269	0	90.7
BTS 8826	245	354.7	103	9905	91	1.08	56.33	105	1566	93	18.81	28.08	147	1674	333	0	86.4
BTS 8839	232	361.0	104	11003	101	0.99	58.11	108	1759	105	19.03	30.62	148	1575	290	0	96.8
BTS 8844	205	358.7	104	11086	102	0.98	57.45	107	1774	105	18.91	31.10	152	1628	269	0	92.4
BTS 8857	235	355.4	103	10394	96	0.98	56.53	105	1641	98	18.75	29.64	140	1552	295	0	83.3
BTS 8864	224	358.3	104	10401	96	1.02	57.33	107	1659	99	18.92	29.24	145	1618	311	0	80.8
BTS 8882	229	360.4	104	12040	111	1.06	57.96	108	1918	114	19.07	33.77	167	1704	303	0	80.3
BTS 8891	226	350.3	101	10276	95	0.98	55.09	102	1614	96	18.50	29.59	151	1574	292	0	91.0
Crystal 684RR	227	340.6	98	12011	111	1.08	52.31	97	1837	109	18.09	35.62	195	1723	303	0	92.2
Crystal 792RR	240	350.8	101	11414	105	1.03	55.22	103	1787	106	18.57	32.64	164	1603	315	0	91.0
Crystal 793RR	238	360.1	104	12264	113	0.98	57.87	108	1967	117	18.98	34.10	139	1539	298	0	89.5
Crystal 796RR	231	348.7	101	12269	113	1.01	54.61	102	1925	114	18.45	35.37	149	1650	287	0	95.5
Crystal 802RR	207	353.6	102	11073	102	1.00	56.02	104	1750	104	18.69	31.49	147	1541	313	0	84.4
Crystal 803RR	244	349.8	101	11261	104	1.00	54.95	102	1768	105	18.50	32.25	191	1555	297	0	94.2
Crystal 804RR	246	342.4	99	11888	110	1.11	52.81	98	1823	108	18.21	35.14	170	1684	349	0	83.3
Crystal 807RR	215	354.7	103	11800	109	0.91	56.32	105	1871	111	18.65	33.30	151	1592	226	0	75.3
Crystal 808RR	218	351.5	102	11575	107	0.98	55.43	103	1818	108	18.56	33.18	159	1612	272	0	91.6
Crystal 809RR	214	350.3	101	10843	100	0.96	55.10	102	1694	101	18.48	30.87	146	1642	251	0	93.3
Hilleshög HIL2230	221	334.9	97	10891	100	1.01	50.67	94	1636	97	17.75	32.74	197	1630	278	0	89.5
Hilleshög HIL2231	208	334.1	97	10095	93	1.07	50.44	94	1527	91	17.76	30.43	195	1742	293	0	86.6
Hilleshög HIL2232	203	347.8	101	11193	103	1.08	54.35	101	1747	104	18.46	32.28	185	1687	313	0	88.7
Hilleshög HIL2233	209	346.6	100	11746	108	0.98	54.02	100	1824	108	18.31	33.83	150	1522	303	0	94.8
Hilleshög HIL2234	217	343.4	99	10908	101	0.98	53.10	99	1679	100	18.15	31.96	166	1653	259	0	95.4
Hilleshög HIL2235	247	335.0	97	10055	93	1.12	50.70	94	1515	90	17.86	30.18	185	1700	354	0	88.6
Hilleshög HIL2236	213	345.9	100	10853	100	1.00	53.83	100	1681	100	18.29	31.89	164	1624	288	0	92.9
Hilleshög HIL9920	223	359.6	104	11779	109	0.95	57.71	107	1876	112	18.92	32.94	161	1689	227	0	88.6
Maribo MA717	248	352.6	102	11797	109	1.01	55.74	104	1858	110	18.65	33.51	174	1627	289	0	94.1
Maribo MA808	234	344.4	100	10284	95	1.00	53.41	99	1594	95	18.22	30.05	192	1715	245	0	92.3
Maribo MA809	233	327.9	95	11004	101	1.06	48.69	90	1627	97	17.44	33.46	193	1780	276	0	83.2
Maribo MA810	220	338.8	98	9469	87	1.18	51.81	96	1435	85	18.11	27.99	177	1763	374	0	75.9
Maribo MA811	206	340.7	99	10527	97	1.07	52.34	97	1617	96	18.11	30.75	191	1726	300	0	78.0
Maribo MA812	222	343.4	99	10314	95	0.95	53.11	99	1582	94	18.12	30.20	169	1472	285	0	94.6
SX RR1879	219	356.9	103	11007	101	0.95	56.96	106	1753	104	18.80	31.10	143	1622	252	0	86.5
SX 1885	212	352.4	102	10917	101	1.02	55.68	103	1729	103	18.65	31.09	145	1727	278	0	79.1
SX 1886	239	343.4	99	10872	100	0.95	53.11	99	1670	99	18.11	31.83	132	1638	257	0	86.0
SX 1887	241	348.6	101	11205	103	1.00	54.57	101	1755	104	18.43	32.44	141	1720	265	0	88.9
SX 1888	216	352.2	102	11573	107	0.99	55.63	103	1819	108	18.60	33.06	148	1654	275	0	83.8
SX 1889	249	341.8	99	9833	91	1.00	52.65	98	1513	90	18.09	28.89	191	1662	263	0	97.2
SV 284	228	339.9	98	10067	93	0.99	52.12	97	1532	91	17.98	29.90	171	1620	277	0	92.9
SV 285	201	346.5	100	10836	100	0.98	53.98	100	1681	100	18.30	31.46	158	1648	267	0	87.0
SV 286	236	341.4	99	10645	98	1.02	52.56	98	1636	97	18.10	31.28	177	1641	293	0	74.7
SV 287	242	338.0	98	11268	104	0.97	51.59	96	1714	102	17.88	33.53	142	1672	263	0	88.3
SV 288	230	344.6	100	10954	101	1.03	53.43	99	1701	101	18.27	31.83	154	1726	291	0	80.7
SV 289	237	349.6	101	11398	105	1.01	54.90	102	1791	106	18.50	32.57	145	1714	274	0	88.0
SV RR371	202	341.9	99	10810	100	1.01	52.67	98	1653	98	18.10	31.91	199	1671	274	0	89.7
SV RR375	204	353.0	102	10904	100	0.96	55.84	104	1724	102	18.62	31.00	141	1651	252	0	89.9
BTS 80RR52(Check)	251	351.6	102	11011	101	1.04	55.47	103	1740	103	18.64	31.32	160	1706	302	0	91.8
Crystal 101RR (Check)	252	340.5	98	11205	103	1.12	52.30	97	1709	102	18.14	33.18	215	1801	310	0	86.2
Crystal 355RR(Check)	253	338.9	98	10226	94	1.04	51.83	96	1559	93	17.99	30.30	154	1677	312	0	93.3
BTS 8572 (Check)	254	352.2	102	10958	101	0.98	55.61	103	1721	102	18.59	31.17	140	1544	302	0	90.2
AP CHK MOD RES RR	255	349.3	101	11163	103	0.97	54.77	102	1744	104	18.44	32.23	177	1674	249	0	92.2
AP CHK SUS HYB#3	256	354.9	103	10120	93	1.01	56.40	105	1604	95	18.76	28.60	182	1681	272	0	85.6
Comm Benchmark Mean		345.8		10850		1.05	53.80		1682		18.34	31.49	167	1682	306		90.4
Comm Trial Mean		339.6		10939		1.00	52.01		1674		17.98	32.25	167	1648	279		87.8
Coeff. of Var. (%)		3.1		5.6		6.1	5.7		7.6		2.8	4.2	19	4.4	11		6.0
Mean LSD (0.05)		13.1		763		0.07	3.75		159		0.62	1.72	37	86	39		6.1
Mean LSD (0.01)		17.3		1007		0.10	4.95		210		0.82	2.27	48	113	52		8.0
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Hillsboro ND — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188305

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 14. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

Climax MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	307.7	102	9820	100	1.00	42.87	105	1367	103	16.40	32.18	126	1651	310	0	93.9
BTS 8337	119	322.1	107	9778	100	1.00	46.99	115	1419	107	17.11	30.52	136	1671	287	0	88.0
BTS 8500	124	301.9	100	10955	112	1.03	41.22	101	1485	111	16.11	36.40	138	1593	314	0	96.5
BTS 8524	127	284.1	94	10203	104	1.08	36.12	88	1292	97	15.28	35.98	172	1741	308	0	89.8
BTS 8606	106	297.8	99	10007	102	1.04	40.03	98	1345	101	15.92	33.55	161	1588	319	0	87.4
BTS 8629	110	298.0	99	11222	114	1.06	40.09	98	1504	113	15.97	37.80	162	1564	353	0	82.3
Crystal 093RR	126	304.9	101	10719	109	1.10	42.08	103	1481	111	16.34	34.94	131	1610	375	0	94.8
Crystal 247RR	113	289.2	96	9450	96	1.04	37.56	92	1224	92	15.50	32.82	181	1625	309	0	94.5
Crystal 355RR	109	306.0	102	9283	95	1.02	42.38	103	1284	96	16.33	30.64	137	1645	322	0	95.1
Crystal 467RR	120	290.7	97	9995	102	1.06	38.00	93	1306	98	15.60	34.34	208	1685	297	0	95.2
Crystal 572RR	112	310.3	103	10239	104	1.00	43.63	106	1447	109	16.51	32.58	126	1456	315	0	93.2
Crystal 573RR	101	303.4	101	10491	107	1.09	41.63	102	1442	108	16.26	34.62	147	1710	337	0	96.8
Crystal 574RR	114	295.7	98	11004	112	0.99	39.44	96	1458	109	15.77	37.44	151	1635	290	0	90.6
Crystal 578RR	115	298.9	99	9425	96	0.99	40.34	98	1264	95	15.93	31.60	160	1622	280	0	93.3
Hilleshög HM4302RR	107	302.0	100	9093	93	0.93	41.25	101	1241	93	16.04	30.25	182	1478	260	0	90.6
Hilleshög HM4448RR	125	306.4	102	10522	107	0.98	42.50	104	1458	109	16.28	34.27	142	1575	285	0	90.0
Hilleshög HM9528RR	117	297.2	99	9607	98	0.93	39.88	97	1287	97	15.78	32.32	155	1445	279	0	87.2
Hilleshög HIL9708	131	295.4	98	9614	98	0.95	39.36	96	1275	96	15.71	32.52	169	1562	251	0	92.7
Maribo MA109	128	308.5	102	8338	85	0.94	43.11	105	1162	87	16.36	27.06	185	1455	268	0	86.1
Maribo MA305	102	294.6	98	10007	102	0.96	39.13	95	1327	100	15.69	33.99	147	1472	293	0	92.7
Maribo MA502	116	299.9	100	9758	100	1.03	40.64	99	1326	100	16.02	32.48	165	1552	328	0	88.9
Maribo MA504	122	294.6	98	10265	105	0.98	39.11	95	1358	102	15.70	34.85	155	1506	303	0	94.4
SX Avalanche RR	129	310.8	103	9412	96	0.87	43.75	107	1317	99	16.41	30.52	147	1404	249	0	85.7
SX Bronco RR(1863)	105	312.1	104	10163	104	0.89	44.14	108	1434	108	16.50	32.58	143	1436	273	0	87.6
SX Canyon RR	103	300.6	100	10027	102	0.96	40.83	100	1365	102	15.99	33.27	136	1536	286	0	88.5
SX Cruze RR	121	278.1	92	9233	94	1.13	34.38	84	1138	85	15.03	33.20	181	1658	362	0	69.6
SX Marathon RR	111	307.9	102	10223	104	0.94	42.94	105	1420	107	16.33	33.17	136	1552	263	0	92.8
SV RR265	108	303.6	101	10228	104	1.01	41.69	102	1406	106	16.20	33.70	144	1715	282	0	92.8
SV RR266	118	301.1	100	9964	102	1.02	41.00	100	1350	101	16.08	33.18	132	1685	301	0	75.8
SV RR268	132	306.1	102	9968	102	0.99	42.40	103	1379	104	16.30	32.80	138	1627	293	0	87.4
SV RR333	123	306.4	102	9710	99	0.95	42.50	104	1349	101	16.26	31.58	131	1606	248	0	84.1
SV RR351	104	303.2	101	9590	98	1.02	41.59	101	1316	99	16.19	31.79	157	1608	307	0	86.4
Crystal 101RR (Check)	133	284.0	94	10245	104	1.12	36.09	88	1302	98	15.33	36.24	208	1675	358	0	93.5
BTS 8572 (Check)	134	306.9	102	9874	101	0.92	42.66	104	1375	103	16.27	32.17	126	1427	289	0	90.4
ACFILL #41	135	281.4	93	8741	89	0.92	35.35	86	1100	83	14.99	31.09	154	1557	241	0	90.3
ACFILL #42	136	300.3	100	9665	99	1.07	40.75	99	1317	99	16.09	32.16	152	1664	326	0	85.0

Experimental Trial (Comm status)																	
BTS 8735	250	307.4	102	10356	106	0.89	42.71	104	1423	107	16.26	34.18	168	1313	288	0	92.9
BTS 8749	243	301.9	100	9995	102	1.04	41.19	100	1359	102	16.13	33.46	157	1576	353	0	87.7
BTS 8767	225	295.9	98	9864	101	0.97	39.55	96	1301	98	15.76	33.70	216	1663	238	0	89.7
BTS 8784	210	313.4	104	9939	101	0.94	44.39	108	1395	105	16.61	31.86	121	1537	283	0	89.8
BTS 8815	211	302.6	100	10023	102	1.00	41.42	101	1373	103	16.14	33.42	172	1581	305	0	94.1
BTS 8826	245	300.3	100	9066	92	1.17	40.76	99	1223	92	16.18	30.65	152	1730	414	0	90.1
BTS 8839	232	300.6	100	10258	105	0.87	40.85	100	1386	104	15.91	34.57	132	1319	285	0	95.3
BTS 8844	205	308.5	102	9517	97	0.96	43.05	105	1326	100	16.40	30.98	169	1516	292	0	91.0
BTS 8857	235	297.9	99	8432	86	0.91	40.10	98	1130	85	15.80	28.54	144	1438	284	0	93.6
BTS 8864	224	308.8	103	8738	89	0.99	43.13	105	1216	91	16.45	28.45	121	1489	340	0	79.4
BTS 8882	229	293.1	97	10266	105	1.02	38.77	95	1349	101	15.68	35.48	149	1637	322	0	83.3
BTS 8891	226	312.7	104	9836	100	1.01	44.20	108	1371	103	16.64	31.78	151	1417	381	0	94.9
Crystal 684RR	227	290.6	96	11298	115	1.06	38.07	93	1462	110	15.58	39.14	165	1592	340	0	95.5
Crystal 792RR	240	312.9	104	10757	110	0.94	44.26	108	1493	112	16.57	34.84	117	1541	277	0	96.1
Crystal 793RR	238	315.9	105	11112	113	0.86	45.09	110	1566	118	16.67	35.93	123	1370	267	0	93.7
Crystal 796RR	231	297.6	99	10785	110	0.92	40.03	98	1456	109	15.82	36.40	148	1438	284	0	96.9
Crystal 802RR	207	307.6	102	10630	108	0.92	42.78	104	1468	110	16.30	34.91	121	1350	311	0	90.5
Crystal 803RR	244	310.2	103	10671	109	0.86	43.51	106	1491	112	16.39	34.92	113	1348	281	0	98.1
Crystal 804RR	246	293.8	98	10791	110	1.04	38.99	95	1410	106	15.73	37.03	169	1402	389	0	90.1
Crystal 807RR	215	296.2	98	9828	100	0.97	39.61	97	1292	97	15.76	33.49	201	1548	276	0	84.8
Crystal 808RR	218	302.7	101	11024	112	1.09	41.43	101	1483	111	16.22	37.03	185	1521	377	0	94.1
Crystal 809RR	214	303.9	101	9320	95	0.97	41.76	102	1270	95	16.16	30.78	169	1523	291	0	92.9
Hilleshög HIL2230	221	307.7	102	10307	105	0.96	42.81	104	1431	107	16.36	33.68	155	1617	262	0	94.6
Hilleshög HIL2231	208	297.0	99	9134	93	1.04	39.86	97	1208	91	15.89	31.12	204	1548	324	0	87.5
Hilleshög HIL2232	203	304.7	101	9268	95	0.96	41.97	102	1271	95	16.22	30.58	159	1434	322	32	93.3
Hilleshög HIL2233	209	307.7	102	10560	108	0.93	42.81	104	1480	111	16.34	34.35	144	1456	289	0	96.1
Hilleshög HIL2234	217	301.3	100	9264	94	0.93	41.04	100	1255	94	16.01	30.91	166	1548	259	0	90.1
Hilleshög HIL2235	247	292.5	97	10011	102	1.15	38.60	94	1316	99	15.79	34.58	181	1720	387	0	94.5
Hilleshög HIL2236	213	305.3	101	9894	101	0.83	42.14	103	1358	102	16.11	32.68	132	1259	262	0	94.8
Hilleshög HIL9920	223	317.1	105	10147	103	0.91	45.39	111	1447	109	16.77	32.16	131	1521	265	0	86.6
Maribo MA717	248	311.9	104	10219	104	0.91	43.99	107	1431	107	16.52	32.93	136	1353	301	0	91.4
Maribo MA808	234	291.7	97	9482	97	1.07	38.39	94	1229	92	15.65	33.15	216	1613	335	0	95.0
Maribo MA809	233	292.0	97	9476	97	0.99	38.49	94	1236	93	15.60	32.83	193	1666	281	0	85.6
Maribo MA810	220	306.1	102	9782	100	1.11	42.39	103	1351	101	16.42	32.04	162	1655	372	0	81.7
Maribo MA811	206	305.0	101	9478	97	0.97	42.05	103	1295	97	16.23	31.46	167	1498	300	0	83.1
Maribo MA812	222	312.3	104	9680	99	0.84	44.09	108	1358	102	16.47	31.10	131	1440	237	0	97.9
SX RR1879	219	305.5	101	10241	104	0.88	42.21	103	1405	106	16.16	33.90	116	1413	273	0	89.3
SX 1885	212	310.6	103	9852	100	0.95	43.61	106	1377	103	16.50	32.10	125	1605	295	0	79.5
SX 1886	239	293.8	98	9537	97	0.99	38.95	95	1264	95	15.69	32.86	181	1496	319	0	89.8
SX 1887	241	304.5	101	10113	103	0.96	41.93	102	1386	104	16.20	33.63	138	1514	306	0	84.7
SX 1888	216	305.4	101	10510	107	0.94	42.15	103	1450	109	16.22	34.55	143	1446	315	0	89.0
SX 1889	249	298.0	99	9087	93	0.98	40.13	98	1211	91	15.89	30.78	188	1480	297	0	93.1
SV 284	228	302.3	100	9376	96	0.94	41.31	101	1262	95	16.04	31.27	178	1449	282	0	93.7
SV 285	201	301.6	100	10021	102	0.95	41.13	100	1364	102	16.04	33.67	137	1459	301	0	88.3
SV 286	236	301.1	100	8977	92	1.01	40.98	100	1223	92	16.08	30.11	139	1687	290	0	87.4
SV 287	242	297.3	99	9850	100	1.01	39.95	97	1305	98	15.89	33.76	129	1700	286	0	87.7
SV 288	230	299.0	99	9315	95	0.97	40.40	99	1257	94	15.93	31.68	147	1546	304	0	90.6
SV 289	237	305.5	101	10145	103	0.91	42.20	103	1398	105	16.20	33.56	132	1400	290	0	89.9
SV RR371	202	295.9	98	9815	100	0.98	39.54	96	1308	98	15.79	33.53	136	1663	296	0	92.5
SV RR375	204	306.4	102	10609	108	0.90	42.46	104	1466	110	16.24	34.95	131	1409	295	0	89.7
BTS 80RR52(Check)	251	295.4	98	9489	97	1.06	39.42	96	1260	95	15.84	32.59	171	1648	330	0	93.5
Crystal 101RR (Check)	252	291.0	97	9429	96	1.07	38.22	93	1241	93	15.63	32.62	187	1698	326	0	92.3
Crystal 355RR(Check)	253	310.2	103	10166	104	1.01	43.50	106	1414	106	16.53	32.94	113	1540	331	0	96.1
BTS 8572 (Check)	254	308.0	102	10138	103	0.93	42.87	105	1413	106	16.33	33.07	127	1511	292	0	89.6
AP CHK MOD RES RR	255	288.7	96	9159	93	1.09	37.56	92	1178	88	15.53	32.01	182	1675	348	0	92.5
AP CHK SUS HYB#3	256	302.7	101	8270	84	0.99	41.45	101	1131	85	16.14	27.30	194	1452	328	0	93.3
Comm Benchmark Mean		301.2		9806		1.02	41.00		1332		16.08	32.81	149	1600	320		92.9
Comm Trial Mean		300.3		9912		1.00	40.76		1342		16.02	33.07	153	1583	299		89.6
Coeff. of Var. (%)		3.4		5.0		8.5	7.1		7.3		2.9	5.0	19	11.2	16		5.0
Mean LSD (0.05)		12.7		620		0.10	3.64		120		0.57	2.12	36	203	59		5.4
Mean LSD (0.01)		16.8		819		0.13	4.80		158		0.76	2.79	48	268	78		7.2
Sig Lvl		**		**		**	**		**		**	**	**	*	**		**

* 2018 Data from Climax MN — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188306

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 15. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

Grand Forks ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	313.9	100	11695	100	1.21	44.66	101	1660	100	16.91	37.33	311	1904	322	0	70.4
BTS 8337	119	322.3	103	11784	101	1.20	47.05	106	1717	104	17.33	36.56	280	1795	354	0	56.5
BTS 8500	124	305.4	98	12914	110	1.27	42.21	95	1783	108	16.54	42.31	327	1864	368	0	63.1
BTS 8524	127	300.9	96	12251	105	1.24	40.93	92	1670	101	16.28	40.63	364	1917	315	0	57.7
BTS 8606	106	319.6	102	12640	108	1.13	46.27	104	1828	110	17.10	39.69	271	1852	287	0	61.6
BTS 8629	110	302.6	97	12563	107	1.22	41.40	93	1716	103	16.34	41.66	333	1702	373	0	53.0
Crystal 093RR	126	320.9	103	11585	99	1.21	46.67	105	1686	102	17.25	36.13	277	1806	361	0	70.0
Crystal 247RR	113	316.0	101	12596	108	1.09	45.24	102	1798	108	16.88	40.06	299	1815	252	0	60.3
Crystal 355RR	109	314.9	101	11452	98	1.28	44.95	101	1629	98	17.03	36.48	331	1823	391	0	67.2
Crystal 467RR	120	308.6	99	12528	107	1.10	43.13	97	1749	105	16.54	40.57	331	1853	239	0	66.2
Crystal 572RR	112	326.8	104	12777	109	1.18	48.35	109	1889	114	17.51	39.12	238	1729	363	0	63.7
Crystal 573RR	101	318.3	102	12181	104	1.23	45.92	104	1756	106	17.15	38.17	311	1758	364	0	68.0
Crystal 574RR	114	302.6	97	12447	106	1.28	41.42	93	1700	103	16.41	41.17	347	1854	368	0	56.0
Crystal 578RR	115	315.0	101	12279	105	1.26	44.97	101	1753	106	17.00	39.02	293	1914	361	0	66.7
Hilleshög HM4302RR	107	305.3	98	11144	95	1.16	42.19	95	1539	93	16.43	36.58	396	1860	267	0	61.4
Hilleshög HM4448RR	125	318.1	102	12807	109	1.13	45.85	103	1841	111	17.02	40.42	283	1707	314	0	64.7
Hilleshög HM9528RR	117	324.4	104	12408	106	1.08	47.67	107	1824	110	17.30	38.19	263	1692	290	0	60.2
Hilleshög HIL9708	131	317.4	101	12013	103	1.12	45.67	103	1728	104	17.00	37.79	301	1739	300	0	63.7
Maribo MA109	128	323.0	103	11093	95	1.20	47.25	107	1619	98	17.35	34.38	343	1740	342	0	52.7
Maribo MA305	102	306.0	98	12070	103	1.09	42.38	96	1672	101	16.40	39.39	310	1672	290	0	56.7
Maribo MA502	116	298.9	96	11248	96	1.35	40.34	91	1517	91	16.30	37.62	421	1906	383	0	66.5
Maribo MA504	122	313.8	100	13052	111	1.11	44.62	101	1856	112	16.81	41.60	287	1816	276	0	61.4
SX Avalanche RR	129	322.7	103	11705	100	1.09	47.16	106	1710	103	17.22	36.28	268	1812	262	0	60.8
SX Bronco RR(1863)	105	310.3	99	11388	97	1.27	43.61	98	1606	97	16.78	36.69	313	1871	378	0	50.9
SX Canyon RR	103	318.2	102	11868	101	1.18	45.87	103	1708	103	17.08	37.37	308	1787	323	0	64.3
SX Cruze RR	121	294.4	94	12095	103	1.16	39.06	88	1605	97	15.89	41.00	323	1806	300	0	50.8
SX Marathon RR	111	320.0	102	13050	111	1.09	46.40	105	1894	114	17.10	40.67	258	1781	275	0	60.2
SV RR265	108	314.5	101	12220	104	1.11	44.82	101	1742	105	16.83	38.87	285	1799	276	0	68.8
SV RR266	118	309.9	99	11659	100	1.19	43.50	98	1630	98	16.68	37.78	293	1763	343	0	55.3
SV RR268	132	312.7	100	11892	102	1.24	44.30	100	1681	101	16.88	38.11	337	1763	370	0	60.5
SV RR333	123	319.5	102	11807	101	1.16	46.27	104	1708	103	17.13	37.01	319	1750	314	0	57.7
SV RR351	104	327.9	105	12459	106	1.05	48.66	110	1846	111	17.44	38.10	215	1810	253	0	56.6
Crystal 101RR (Check)	133	298.9	96	11151	95	1.30	40.35	91	1505	91	16.24	37.35	416	1924	344	0	60.1
BTS 8572 (Check)	134	323.8	103	12547	107	1.18	47.49	107	1839	111	17.37	38.83	216	1756	375	0	58.3
ACFILL #41	135	293.1	94	10951	94	1.09	38.69	87	1438	87	15.74	37.57	324	1717	272	0	58.0
ACFILL #42	136	295.9	95	11163	95	1.42	39.51	89	1483	89	16.23	37.79	468	1877	432	0	64.1

Experimental Trial (Comm status)																	
BTS 8735	250	308.5	99	11878	101	1.16	43.15	97	1649	99	16.58	38.80	320	1636	349	0	65.0
BTS 8749	243	327.9	105	12264	105	1.16	48.45	109	1806	109	17.56	37.71	235	1812	334	0	69.4
BTS 8767	225	312.8	100	12128	104	1.06	44.33	100	1706	103	16.72	38.92	239	1813	256	0	67.1
BTS 8784	210	331.8	106	12223	104	1.08	49.52	112	1819	110	17.69	36.82	192	1616	348	0	66.1
BTS 8815	211	311.9	100	11906	102	1.12	44.10	99	1684	102	16.73	38.11	293	1856	274	0	59.6
BTS 8826	245	320.3	102	11280	96	1.30	46.38	105	1631	98	17.31	35.20	292	1854	419	0	57.1
BTS 8839	232	321.3	103	12323	105	1.06	46.67	105	1787	108	17.15	38.44	272	1650	288	0	70.4
BTS 8844	205	311.9	100	11583	99	1.24	44.09	99	1635	99	16.83	36.90	353	1798	362	0	62.9
BTS 8857	235	318.8	102	10768	92	1.08	45.98	104	1551	94	17.04	33.76	232	1696	306	0	54.6
BTS 8864	224	323.7	103	10941	93	1.11	47.31	107	1598	96	17.32	33.89	207	1719	337	0	55.3
BTS 8882	229	303.7	97	12207	104	1.20	41.86	94	1679	101	16.39	40.20	312	1896	322	0	56.9
BTS 8891	226	332.4	106	12052	103	1.10	49.69	112	1800	109	17.75	36.16	221	1747	316	0	64.5
Crystal 684RR	227	305.8	98	12925	110	1.19	42.42	96	1785	108	16.48	42.34	304	1904	307	0	64.2
Crystal 792RR	240	318.1	102	11893	102	1.18	45.79	103	1707	103	17.09	37.45	288	1704	353	0	66.5
Crystal 793RR	238	332.8	106	13374	114	1.03	49.80	112	1995	120	17.70	40.14	211	1641	293	0	62.5
Crystal 796RR	231	316.5	101	12770	109	1.09	45.34	102	1829	110	16.93	40.59	253	1767	280	0	64.4
Crystal 802RR	207	326.3	104	12003	102	1.03	48.00	108	1757	106	17.36	36.89	221	1608	288	0	61.0
Crystal 803RR	244	319.5	102	12395	106	1.18	46.17	104	1792	108	17.16	38.79	295	1797	331	0	67.3
Crystal 804RR	246	309.7	99	12721	109	1.23	43.50	98	1772	107	16.72	41.17	348	1869	338	0	58.7
Crystal 807RR	215	322.4	103	12120	103	1.05	46.95	106	1756	106	17.19	37.75	257	1848	237	0	57.4
Crystal 808RR	218	324.9	104	12683	108	1.13	47.65	107	1860	112	17.40	39.07	281	1816	298	0	66.5
Crystal 809RR	214	306.5	98	11547	99	1.27	42.62	96	1606	97	16.59	37.57	380	1879	348	0	59.6
Hilleshög HIL2230	221	316.9	101	11526	98	1.14	45.46	102	1647	99	17.00	36.52	258	1717	352	0	60.4
Hilleshög HIL2231	208	296.3	95	10581	90	1.24	39.84	90	1422	86	16.04	35.65	382	1940	311	0	55.1
Hilleshög HIL2232	203	314.6	101	11298	96	1.23	44.83	101	1609	97	16.96	35.89	329	1809	356	0	63.6
Hilleshög HIL2233	209	331.3	106	11767	100	1.03	49.38	111	1749	105	17.62	35.58	202	1673	280	0	61.2
Hilleshög HIL2234	217	302.8	97	11190	96	1.27	41.59	94	1537	93	16.40	36.92	438	1820	345	0	66.7
Hilleshög HIL2235	247	321.1	103	11896	102	1.16	46.61	105	1725	104	17.22	37.14	271	1865	301	0	63.6
Hilleshög HIL2236	213	313.0	100	11234	96	1.18	44.41	100	1598	96	16.83	36.00	307	1680	355	0	69.3
Hilleshög HIL9920	223	317.0	101	11926	102	1.11	45.50	103	1705	103	16.97	37.77	267	1822	281	0	66.1
Maribo MA717	248	316.7	101	11306	97	1.23	45.38	102	1618	98	17.06	35.60	355	1765	361	0	63.4
Maribo MA808	234	307.0	98	10835	93	1.18	42.75	96	1502	91	16.53	35.29	387	1936	259	0	72.7
Maribo MA809	233	297.0	95	11931	102	1.17	40.03	90	1608	97	16.02	40.21	383	1828	285	0	58.3
Maribo MA810	220	314.0	100	11442	98	1.20	44.67	101	1616	97	16.91	36.62	279	1884	329	0	49.8
Maribo MA811	206	310.9	99	11040	94	1.16	43.82	99	1550	93	16.71	35.57	316	1857	294	0	50.9
Maribo MA812	222	325.4	104	11803	101	1.08	47.78	108	1731	104	17.38	36.22	217	1682	317	0	76.5
SX RR1879	219	315.0	101	11878	101	1.17	44.94	101	1688	102	16.93	38.13	280	1851	310	0	71.5
SX 1885	212	311.1	99	11557	99	1.10	43.88	99	1626	98	16.68	37.21	293	1759	275	0	50.4
SX 1886	239	314.2	100	11855	101	1.17	44.72	101	1680	101	16.89	37.69	255	1865	328	0	59.2
SX 1887	241	314.3	100	11380	97	1.13	44.76	101	1617	98	16.87	36.13	276	1810	306	0	61.8
SX 1888	216	320.7	103	11912	102	1.10	46.51	105	1726	104	17.16	37.12	255	1741	299	0	64.6
SX 1889	249	315.2	101	10728	92	1.20	45.01	101	1528	92	16.96	33.92	399	1811	300	0	70.0
SV 284	228	312.7	100	11246	96	1.13	44.29	100	1584	96	16.78	35.89	333	1736	298	0	65.7
SV 285	201	318.3	102	11855	101	1.05	45.83	103	1709	103	16.98	37.21	220	1771	259	0	64.6
SV 286	236	318.4	102	11742	100	1.11	45.86	103	1686	102	17.05	37.12	292	1764	299	0	52.4
SV 287	242	299.3	96	12065	103	1.14	40.65	92	1635	99	16.11	40.28	285	1862	291	0	62.2
SV 288	230	298.6	95	11287	96	1.21	40.47	91	1520	92	16.14	38.16	352	1815	325	0	64.1
SV 289	237	330.5	106	12261	105	1.05	49.18	111	1823	110	17.61	37.21	215	1816	256	0	57.3
SV RR371	202	323.9	104	11880	101	1.08	47.36	107	1736	105	17.30	36.93	220	1835	276	0	61.2
SV RR375	204	316.5	101	12247	105	1.16	45.34	102	1751	106	16.99	38.89	287	1771	328	0	62.4
BTS 80RR52(Check)	251	304.7	97	11242	96	1.35	42.13	95	1552	94	16.57	36.99	404	1832	422	0	68.3
Crystal 101RR (Check)	252	300.5	96	11452	98	1.27	40.99	92	1566	94	16.29	38.18	342	2041	317	0	66.4
Crystal 355RR(Check)	253	307.6	98	11718	100	1.32	42.92	97	1633	98	16.70	38.05	350	1866	406	0	73.0
BTS 8572 (Check)	254	338.7	108	12433	106	1.03	51.41	116	1882	114	17.99	36.77	176	1669	287	0	57.3
AP CHK MOD RES RR	255	315.6	101	11993	102	1.12	45.11	102	1713	103	16.92	38.11	285	1887	265	0	69.6
AP CHK SUS HYB#3	256	316.3	101	10684	91	1.25	45.29	102	1527	92	17.07	33.80	408	1861	331	0	58.2
Comm Benchmark Mean		312.9		11711		1.24	44.36		1658		16.89	37.50	318	1852	358		66.2
Comm Trial Mean		312.7		12041		1.18	44.30		1704		16.82	38.56	313	1804	325		60.9
Coeff. of Var. (%)		3.5		5.5		9.3	7.1		8.3		2.9	4.3	23	4.8	19		10.7
Mean LSD (0.05)		14.1		833		0.14	4.05		179		0.62	2.10	91	109	79		7.9
Mean LSD (0.01)		18.7		1101		0.19	5.35		237		0.82	2.78	121	144	104		10.4
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**
* 2018 Data from Grand Forks ND		Bolters per acre are based upon 45,000 plants per acre.													Created 11/2/2018		
@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial.															Trial # = 188307		
++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.																	

Table 16. 2018 Performance of Varieties - ACSC Experimental RR Official Trial
Scandia MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	345.6	100	10792	97	0.97	53.74	99	1678	96	18.27	31.19	134	1553	292	0	86.6
BTS 8337	119	356.1	103	11107	99	0.92	56.74	105	1767	101	18.74	31.22	138	1536	253	0	81.8
BTS 8500	124	343.9	99	11930	107	0.93	53.23	98	1843	106	18.12	34.73	159	1517	259	0	93.2
BTS 8524	127	332.3	96	11857	106	0.95	49.91	92	1780	102	17.56	35.73	160	1557	266	0	86.8
BTS 8606	106	345.8	100	11992	107	0.85	53.78	99	1863	107	18.13	34.75	102	1439	240	0	86.7
BTS 8629	110	341.2	98	12638	113	0.86	52.48	97	1944	112	17.91	37.05	148	1338	258	0	75.3
Crystal 093RR	126	357.7	103	11864	106	0.93	57.20	106	1898	109	18.83	33.18	129	1479	282	0	88.5
Crystal 247RR	113	346.1	100	12224	109	0.82	53.88	99	1901	109	18.12	35.38	136	1425	207	0	88.8
Crystal 355RR	109	349.3	101	10784	97	1.00	54.79	101	1689	97	18.47	30.89	146	1572	300	0	92.1
Crystal 467RR	120	338.5	97	11991	107	0.87	51.71	95	1831	105	17.79	35.44	166	1539	206	0	89.1
Crystal 572RR	112	352.9	102	11758	105	0.92	55.81	103	1864	107	18.57	33.25	120	1502	269	0	88.1
Crystal 573RR	101	348.7	100	11680	105	0.95	54.63	101	1825	105	18.38	33.59	148	1500	281	0	90.5
Crystal 574RR	114	337.6	97	12289	110	0.93	51.44	95	1873	108	17.80	36.41	159	1551	250	0	84.5
Crystal 578RR	115	338.0	97	11799	106	0.90	51.55	95	1799	103	17.80	34.92	149	1512	236	0	88.7
Hilleshög HM4302RR	107	343.1	99	11241	101	0.89	53.01	98	1733	99	18.05	32.83	155	1542	222	0	87.1
Hilleshög HM4448RR	125	346.9	100	12555	112	0.89	54.12	100	1959	112	18.23	36.21	145	1438	254	0	89.6
Hilleshög HM9528RR	117	337.2	97	10819	97	0.87	51.33	95	1640	94	17.73	32.26	170	1441	232	0	76.6
Hilleshög HIL9708	131	347.7	100	11945	107	0.85	54.32	100	1866	107	18.22	34.38	147	1449	219	0	87.9
Maribo MA109	128	355.3	102	10619	95	0.86	56.51	104	1690	97	18.63	29.85	137	1449	236	0	78.1
Maribo MA305	102	336.9	97	11604	104	0.83	51.24	95	1763	101	17.68	34.47	140	1387	225	0	77.2
Maribo MA502	116	342.6	99	11296	101	0.88	52.86	98	1744	100	18.01	32.96	165	1496	225	0	79.4
Maribo MA504	122	353.3	102	13214	118	0.87	55.94	103	2091	120	18.53	37.41	144	1450	236	0	88.7
SX Avalanche RR	129	349.7	101	10920	98	0.90	54.92	101	1711	98	18.38	31.34	150	1469	250	0	85.5
SX Bronco RR(1863)	105	353.5	102	11381	102	0.85	56.01	103	1801	103	18.53	32.22	134	1491	214	0	77.6
SX Canyon RR	103	350.5	101	11130	100	0.86	55.13	102	1748	100	18.38	31.86	120	1476	232	0	81.2
SX Cruze RR	121	322.0	93	10970	98	0.96	46.98	87	1600	92	17.06	34.07	151	1522	283	0	67.1
SX Marathon RR	111	348.2	100	11950	107	0.86	54.47	100	1870	107	18.27	34.27	127	1459	234	0	81.1
SV RR265	108	346.2	100	11941	107	0.87	53.91	99	1857	107	18.18	34.55	140	1452	236	0	81.2
SV RR266	118	344.7	99	11210	100	0.91	53.47	99	1735	100	18.14	32.61	147	1471	263	0	75.3
SV RR268	132	353.4	102	11547	103	0.88	55.96	103	1822	105	18.54	32.78	125	1477	245	0	83.9
SV RR333	123	348.8	100	11217	100	0.85	54.65	101	1761	101	18.30	32.11	108	1463	228	0	76.8
SV RR351	104	352.9	102	11931	107	0.89	55.83	103	1881	108	18.54	33.88	127	1505	244	0	77.7
Crystal 101RR (Check)	133	335.3	97	11490	103	1.04	50.77	94	1741	100	17.81	34.27	207	1729	273	0	85.7
BTS 8572 (Check)	134	358.9	103	11594	104	0.83	57.54	106	1860	107	18.78	32.29	112	1377	230	0	83.0
ACFILL #41	135	325.8	94	10540	94	0.86	48.06	89	1554	89	17.15	32.38	147	1472	225	0	88.4
ACFILL #42	136	332.0	96	10560	95	1.07	49.82	92	1583	91	17.66	31.83	216	1675	309	0	91.8

Experimental Trial (Comm status)																	
BTS 8735	250	341.6	98	11949	107	0.79	52.62	97	1853	106	17.88	34.81	147	1270	219	0	88.5
BTS 8749	243	346.2	100	11437	102	0.89	53.91	99	1780	102	18.21	33.06	199	1483	224	0	87.1
BTS 8767	225	339.1	98	12306	110	0.87	51.90	96	1881	108	17.82	36.38	177	1443	226	0	92.0
BTS 8784	210	357.1	103	11885	106	0.81	56.98	105	1909	110	18.69	33.05	114	1356	225	0	87.0
BTS 8815	211	351.9	101	11830	106	0.85	55.51	102	1864	107	18.46	33.61	145	1488	210	0	86.1
BTS 8826	245	344.4	99	10395	93	0.98	53.41	99	1620	93	18.23	30.06	180	1534	291	0	88.3
BTS 8839	232	350.1	101	11321	101	0.82	55.01	101	1776	102	18.33	32.40	153	1320	230	0	92.3
BTS 8844	205	353.8	102	11603	104	0.87	56.05	103	1838	106	18.57	32.79	154	1441	235	0	92.6
BTS 8857	235	343.0	99	11011	99	0.83	53.00	98	1706	98	18.00	32.01	132	1417	218	0	80.4
BTS 8864	224	353.1	102	11767	105	0.95	55.83	103	1864	107	18.63	33.27	145	1476	293	0	84.9
BTS 8882	229	344.0	99	12452	112	0.99	53.29	98	1935	111	18.20	36.13	181	1559	288	0	78.8
BTS 8891	226	351.3	101	11403	102	0.90	55.35	102	1792	103	18.48	32.51	146	1424	268	0	91.9
Crystal 684RR	227	340.7	98	12358	111	0.92	52.37	97	1903	109	17.96	36.23	211	1549	226	0	94.8
Crystal 792RR	240	348.8	100	12439	111	0.94	54.66	101	1951	112	18.40	35.63	155	1473	282	0	89.0
Crystal 793RR	238	349.7	101	12246	110	0.85	54.90	101	1926	111	18.34	34.94	164	1382	230	0	91.4
Crystal 796RR	231	340.1	98	12672	113	0.86	52.17	96	1950	112	17.87	37.15	142	1494	219	0	94.5
Crystal 802RR	207	356.8	103	11897	107	0.81	56.88	105	1900	109	18.66	33.32	144	1324	224	0	88.1
Crystal 803RR	244	350.7	101	12660	113	0.83	55.19	102	1997	115	18.37	36.02	142	1385	225	0	96.5
Crystal 804RR	246	339.5	98	12439	111	0.93	52.04	96	1916	110	17.92	36.48	176	1475	267	0	83.0
Crystal 807RR	215	344.6	99	12313	110	0.83	53.47	99	1919	110	18.07	35.57	163	1471	193	0	82.3
Crystal 808RR	218	342.7	99	13008	117	0.91	52.92	98	2014	116	18.06	37.87	196	1483	238	0	92.1
Crystal 809RR	214	349.0	101	10851	97	0.87	54.71	101	1707	98	18.33	30.95	151	1483	225	0	92.6
Hilleshög HIL2230	221	355.4	102	11726	105	0.84	56.49	104	1861	107	18.62	33.02	129	1372	238	0	95.8
Hilleshög HIL2231	208	341.9	98	11072	99	0.88	52.69	97	1714	98	17.98	32.24	172	1484	224	0	88.7
Hilleshög HIL2232	203	355.3	102	11483	103	0.92	56.49	104	1828	105	18.71	32.27	210	1445	254	60	88.8
Hilleshög HIL2233	209	353.5	102	12052	108	0.87	55.94	103	1913	110	18.55	33.98	150	1369	249	0	92.3
Hilleshög HIL2234	217	339.9	98	10896	98	0.87	52.13	96	1674	96	17.87	32.08	178	1445	229	0	90.0
Hilleshög HIL2235	247	348.7	100	11479	103	0.94	54.63	101	1804	104	18.38	32.81	181	1515	256	0	91.4
Hilleshög HIL2236	213	355.4	102	11113	100	0.82	56.51	104	1773	102	18.61	31.18	145	1368	224	0	91.1
Hilleshög HIL9920	223	357.0	103	11716	105	0.89	56.96	105	1873	108	18.75	32.77	160	1474	238	0	89.1
Maribo MA717	248	356.1	103	11620	104	0.87	56.69	105	1859	107	18.70	32.43	128	1408	251	0	91.7
Maribo MA808	234	336.6	97	11118	100	0.96	51.20	94	1696	97	17.79	32.96	218	1591	244	0	94.6
Maribo MA809	233	335.8	97	11736	105	0.96	50.97	94	1788	103	17.77	34.88	212	1568	252	0	92.6
Maribo MA810	220	354.2	102	10642	95	1.03	56.16	104	1690	97	18.76	29.99	203	1586	301	0	82.6
Maribo MA811	206	356.5	103	11714	105	0.87	56.81	105	1870	107	18.72	32.76	170	1532	210	0	75.9
Maribo MA812	222	355.4	102	11366	102	0.77	56.52	104	1809	104	18.57	31.91	121	1275	215	0	93.8
SX RR1879	219	349.8	101	11825	106	0.82	54.93	101	1855	107	18.33	33.82	123	1386	224	0	85.6
SX 1885	212	352.6	102	10993	98	0.91	55.71	103	1742	100	18.55	31.09	139	1461	264	0	80.8
SX 1886	239	343.6	99	10995	98	0.86	53.20	98	1703	98	18.04	32.04	146	1397	240	0	85.6
SX 1887	241	357.4	103	11397	102	0.87	57.07	105	1827	105	18.75	31.80	142	1482	227	0	80.5
SX 1888	216	353.5	102	12219	109	0.79	55.94	103	1938	111	18.47	34.46	105	1388	204	0	85.3
SX 1889	249	345.6	100	10614	95	0.89	53.75	99	1650	95	18.19	30.70	184	1473	231	0	89.9
SV 284	228	346.1	100	11624	104	0.89	53.87	99	1811	104	18.21	33.52	181	1423	249	0	93.7
SV 285	201	349.4	101	11401	102	0.87	54.82	101	1791	103	18.34	32.61	142	1452	236	0	85.1
SV 286	236	349.8	101	11884	106	0.92	54.92	101	1872	107	18.41	33.91	145	1452	270	0	83.3
SV 287	242	345.0	99	10991	98	0.87	53.56	99	1715	98	18.16	31.68	151	1502	226	0	91.8
SV 288	230	337.0	97	11508	103	0.87	51.30	95	1762	101	17.74	34.02	166	1419	241	0	86.2
SV 289	237	353.7	102	11475	103	0.82	56.03	103	1826	105	18.52	32.30	144	1428	202	0	84.6
SV RR371	202	349.6	101	11853	106	0.87	54.87	101	1869	107	18.36	33.71	144	1451	233	0	91.1
SV RR375	204	349.4	101	11606	104	0.82	54.83	101	1822	105	18.32	33.17	134	1402	220	0	91.8
BTS 80RR52(Check)	251	342.3	99	10949	98	0.99	52.79	97	1689	97	18.11	31.96	166	1598	280	0	89.9
Crystal 101RR (Check)	252	336.1	97	11319	101	1.01	51.05	94	1716	99	17.82	33.75	195	1667	272	0	93.8
Crystal 355RR(Check)	253	357.9	103	11154	100	0.99	57.20	106	1785	102	18.89	31.16	121	1548	311	0	90.8
BTS 8572 (Check)	254	352.9	102	11238	101	0.84	55.79	103	1778	102	18.50	31.77	117	1418	231	0	92.3
AP CHK MOD RES RR	255	345.1	99	12292	110	0.82	53.59	99	1914	110	18.08	35.58	164	1414	199	0	88.4
AP CHK SUS HYB#3	256	344.4	99	11098	99	0.94	53.39	98	1731	99	18.17	32.04	216	1466	258	0	89.5
Comm Benchmark Mean		347.3		11165		0.96	54.21		1742		18.33	32.16	150	1558	274		91.7
Comm Trial Mean		345.0		11566		0.90	53.55		1793		18.15	33.57	145	1492	248		83.9
Coeff. of Var. (%)		2.1		5.0		7.1	3.9		5.6		1.9	5.1	19	4.4	14		6.2
Mean LSD (0.05)		9.2		733		0.08	2.63		126		0.44	2.18	35	78	42		6.4
Mean LSD (0.01)		12.1		968		0.10	3.48		167		0.58	2.88	46	103	55		8.5
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Scandia MN — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188308

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 17. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

East Grand

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	346.3	99	11844	101	0.91	53.92	99	1829	100	18.21	34.50	129	1537	248	0	81.9
BTS 8337	119	363.5	104	11868	101	0.91	58.86	108	1925	105	19.07	32.53	120	1581	238	0	78.7
BTS 8500	124	340.2	98	12870	110	0.95	52.19	96	1971	108	17.95	37.88	135	1626	253	0	87.6
BTS 8524	127	332.1	95	12336	105	0.97	49.85	91	1847	101	17.56	37.11	160	1657	251	0	79.2
BTS 8606	106	349.7	100	12389	105	0.91	54.91	101	1929	105	18.39	35.70	132	1554	241	0	83.6
BTS 8629	110	350.8	101	12186	104	0.79	55.22	101	1909	104	18.34	34.96	111	1321	221	0	71.7
Crystal 093RR	126	355.7	102	12099	103	0.93	56.61	104	1927	105	18.71	34.02	108	1480	289	0	88.7
Crystal 247RR	113	345.1	99	12152	103	0.83	53.58	98	1895	104	18.10	35.20	140	1506	195	0	85.0
Crystal 355RR	109	354.4	102	11677	99	0.95	56.25	103	1860	102	18.67	32.77	123	1600	271	0	86.6
Crystal 467RR	120	339.7	97	12176	104	0.87	52.03	95	1858	102	17.86	35.80	155	1539	212	0	86.2
Crystal 572RR	112	357.6	103	12201	104	0.92	57.17	105	1949	107	18.80	34.19	109	1508	275	0	80.8
Crystal 573RR	101	352.8	101	12375	105	0.89	55.79	102	1963	107	18.54	35.14	111	1533	245	0	87.7
Crystal 574RR	114	347.5	100	13087	111	0.91	54.26	99	2038	111	18.28	37.66	128	1590	237	0	80.3
Crystal 578RR	115	347.3	100	11692	100	0.86	54.21	99	1821	100	18.24	33.80	121	1543	216	0	84.0
Hilleshög HM4302RR	107	350.3	100	11324	96	0.91	55.08	101	1780	97	18.42	32.21	145	1607	227	0	80.8
Hilleshög HM4448RR	125	343.0	98	12562	107	0.87	52.99	97	1933	106	18.03	36.79	129	1514	227	0	83.9
Hilleshög HM9528RR	117	348.5	100	10941	93	0.90	54.55	100	1716	94	18.34	31.48	122	1544	248	0	71.2
Hilleshög HIL9708	131	362.1	104	12606	107	0.86	58.46	107	2048	112	18.96	34.59	107	1512	225	0	89.2
Maribo MA109	128	358.8	103	10995	94	0.91	57.53	105	1774	97	18.87	30.60	130	1551	250	0	78.0
Maribo MA305	102	338.9	97	11457	98	0.86	51.83	95	1749	96	17.81	34.00	131	1463	230	0	76.3
Maribo MA502	116	336.3	96	11263	96	0.94	51.06	94	1700	93	17.76	33.76	169	1651	231	0	83.2
Maribo MA504	122	342.2	98	12809	109	0.89	52.75	97	1975	108	18.01	37.42	124	1558	236	0	87.1
SX Avalanche RR	129	352.0	101	11504	98	0.87	55.57	102	1809	99	18.47	32.81	127	1517	223	0	77.3
SX Bronco RR(1863)	105	349.7	100	11867	101	0.89	54.91	101	1855	101	18.37	33.99	130	1544	233	0	72.5
SX Canyon RR	103	348.2	100	12832	109	0.86	54.47	100	2006	110	18.27	36.84	120	1561	211	0	79.5
SX Cruze RR	121	327.1	94	11100	94	0.99	48.44	89	1647	90	17.34	33.88	147	1641	278	0	55.2
SX Marathon RR	111	352.5	101	12617	107	0.86	55.70	102	2006	110	18.49	35.65	113	1554	217	0	82.4
SV RR265	108	348.7	100	12130	103	0.85	54.62	100	1895	104	18.27	34.88	106	1529	209	0	80.6
SV RR266	118	356.9	102	12438	106	0.85	56.96	104	1981	108	18.69	35.02	106	1520	214	0	70.1
SV RR268	132	354.9	102	11989	102	0.90	56.39	103	1893	103	18.64	34.05	125	1589	230	0	77.6
SV RR333	123	355.6	102	11924	102	0.84	56.60	104	1913	105	18.61	33.29	101	1529	208	0	74.7
SV RR351	104	351.1	101	11620	99	0.92	55.30	101	1822	100	18.47	33.21	118	1620	236	0	71.3
Crystal 101RR (Check)	133	341.8	98	11716	100	0.96	52.64	96	1783	97	18.04	34.61	150	1705	236	0	83.0
BTS 8572 (Check)	134	351.8	101	11754	100	0.96	55.50	102	1847	101	18.55	33.54	121	1524	294	0	81.6
ACFILL #41	135	325.6	93	10644	91	0.86	47.99	88	1563	85	17.13	32.72	130	1510	217	0	80.5
ACFILL #42	136	332.4	95	10680	91	0.98	49.94	92	1600	87	17.61	32.23	178	1633	262	0	83.2

Experimental Trial (Comm status)																	
BTS 8735	250	351.2	101	11252	96	0.79	55.31	101	1771	97	18.35	31.96	112	1363	208	0	81.4
BTS 8749	243	350.8	101	12386	105	0.92	55.22	101	1935	106	18.46	35.43	126	1569	254	0	85.9
BTS 8767	225	341.4	98	12382	105	0.88	52.58	96	1904	104	17.95	36.28	154	1497	228	0	85.9
BTS 8784	210	360.5	103	11239	96	0.84	57.93	106	1801	98	18.87	31.24	106	1371	256	0	77.4
BTS 8815	211	355.0	102	12426	106	0.86	56.38	103	1963	107	18.60	35.12	126	1497	218	0	78.0
BTS 8826	245	356.4	102	11031	94	0.95	56.79	104	1759	96	18.77	30.91	123	1547	283	0	78.7
BTS 8839	232	362.0	104	10994	94	0.80	58.33	107	1773	97	18.89	30.23	110	1384	209	0	81.5
BTS 8844	205	346.5	99	11998	102	0.85	54.00	99	1872	102	18.17	34.43	144	1517	201	0	81.9
BTS 8857	235	342.3	98	10654	91	0.89	52.82	97	1644	90	18.01	31.03	113	1520	249	0	74.2
BTS 8864	224	354.4	102	10996	94	0.86	56.22	103	1737	95	18.58	31.14	110	1424	248	0	69.5
BTS 8882	229	345.6	99	12498	106	0.89	53.75	98	1936	106	18.16	36.12	141	1561	219	0	71.3
BTS 8891	226	361.6	104	11631	99	0.85	58.23	107	1862	102	18.93	32.25	118	1412	242	0	81.7
Crystal 684RR	227	342.9	98	12219	104	0.91	52.97	97	1877	103	18.05	35.84	140	1573	239	0	85.5
Crystal 792RR	240	353.6	101	11794	100	0.87	55.98	103	1860	102	18.54	33.45	117	1454	250	0	83.3
Crystal 793RR	238	359.5	103	12892	110	0.77	57.65	106	2067	113	18.75	35.85	95	1338	202	0	78.8
Crystal 796RR	231	345.6	99	12483	106	0.89	53.74	98	1934	106	18.16	36.09	131	1502	241	0	89.7
Crystal 802RR	207	355.6	102	11407	97	0.87	56.54	104	1822	100	18.64	31.85	119	1417	257	0	76.4
Crystal 803RR	244	358.0	103	12888	110	0.82	57.20	105	2056	112	18.71	35.96	102	1396	225	0	87.3
Crystal 804RR	246	343.3	98	12385	105	0.90	53.09	97	1909	104	18.05	36.09	154	1490	248	0	78.5
Crystal 807RR	215	349.4	100	12275	104	0.80	54.81	100	1930	105	18.26	34.96	128	1413	199	0	60.3
Crystal 808RR	218	345.3	99	12729	108	0.87	53.64	98	1975	108	18.13	36.73	149	1502	224	0	81.8
Crystal 809RR	214	346.8	99	11553	98	0.88	54.10	99	1802	98	18.22	33.23	144	1539	222	0	83.7
Hilleshög HIL2230	221	351.7	101	11262	96	0.88	55.47	102	1768	97	18.47	32.15	125	1480	249	0	91.2
Hilleshög HIL2231	208	338.6	97	10444	89	0.89	51.77	95	1586	87	17.82	31.03	144	1610	209	0	71.7
Hilleshög HIL2232	203	362.5	104	11183	95	0.95	58.48	107	1811	99	19.06	30.59	126	1584	272	0	89.0
Hilleshög HIL2233	209	356.6	102	12213	104	0.89	56.82	104	1941	106	18.71	34.27	124	1472	250	0	86.4
Hilleshög HIL2234	217	345.7	99	11190	95	0.86	53.77	99	1737	95	18.14	32.30	142	1521	211	0	81.5
Hilleshög HIL2235	247	344.0	99	11403	97	1.03	53.28	98	1757	96	18.22	33.22	146	1655	307	0	82.0
Hilleshög HIL2236	213	359.2	103	10901	93	0.89	57.56	105	1750	96	18.85	30.23	115	1504	250	0	86.3
Hilleshög HIL9920	223	364.5	105	11825	101	0.83	59.06	108	1922	105	19.05	32.17	116	1490	205	0	83.9
Maribo MA717	248	366.8	105	11833	101	0.87	59.68	109	1914	105	19.21	32.36	119	1476	243	0	93.5
Maribo MA808	234	337.5	97	10317	88	0.90	51.48	94	1566	86	17.77	30.62	177	1608	200	0	93.4
Maribo MA809	233	339.3	97	11968	102	0.93	51.98	95	1830	100	17.89	35.21	152	1650	230	0	78.6
Maribo MA810	220	345.9	99	11097	94	0.97	53.84	99	1716	94	18.26	32.22	142	1621	270	0	74.2
Maribo MA811	206	352.9	101	12007	102	0.90	55.77	102	1895	104	18.53	33.94	143	1552	231	0	72.4
Maribo MA812	222	359.1	103	10497	89	0.82	57.53	105	1680	92	18.78	29.19	116	1407	220	0	90.9
SX RR1879	219	349.0	100	12464	106	0.86	54.69	100	1948	106	18.30	35.66	114	1532	217	0	85.6
SX 1885	212	348.9	100	11930	102	0.86	54.67	100	1861	102	18.30	34.22	120	1493	223	0	72.8
SX 1886	239	352.3	101	11826	101	0.85	55.61	102	1866	102	18.46	33.55	116	1509	211	60	74.5
SX 1887	241	353.1	101	11676	99	0.86	55.83	102	1828	100	18.50	33.35	116	1514	217	0	75.5
SX 1888	216	350.2	100	12251	104	0.87	55.04	101	1919	105	18.38	34.98	117	1551	219	0	75.5
SX 1889	249	351.9	101	11584	99	0.85	55.51	102	1824	100	18.45	33.03	122	1513	210	0	81.8
SV 284	228	352.9	101	11867	101	0.83	55.77	102	1869	102	18.47	33.71	115	1427	219	0	81.9
SV 285	201	353.9	102	12596	107	0.85	56.06	103	1993	109	18.54	35.60	110	1508	221	0	76.4
SV 286	236	347.7	100	11211	95	0.83	54.34	100	1750	96	18.21	32.20	115	1423	224	0	69.6
SV 287	242	352.0	101	12159	104	0.83	55.53	102	1910	104	18.43	34.68	109	1498	205	0	79.3
SV 288	230	336.8	97	11685	99	0.90	51.25	94	1773	97	17.73	34.70	128	1584	228	0	76.9
SV 289	237	348.9	100	12190	104	0.87	54.64	100	1913	105	18.30	34.81	125	1513	221	0	75.4
SV RR371	202	349.0	100	11947	102	0.83	54.68	100	1873	102	18.27	34.20	111	1504	199	0	80.0
SV RR375	204	348.6	100	11690	100	0.84	54.57	100	1820	99	18.27	33.69	119	1475	219	0	78.9
BTS 80RR52(Check)	251	351.5	101	12161	104	0.97	55.41	102	1904	104	18.54	34.74	128	1604	284	0	84.6
Crystal 101RR (Check)	252	342.5	98	11785	100	0.96	52.87	97	1814	99	18.07	34.51	143	1723	231	0	83.5
Crystal 355RR(Check)	253	351.6	101	11574	99	0.95	55.43	102	1810	99	18.52	33.08	125	1560	276	0	86.3
BTS 8572 (Check)	254	348.7	100	11471	98	0.90	54.60	100	1791	98	18.33	33.10	127	1478	257	0	85.3
AP CHK MOD RES RR	255	339.6	97	11736	100	0.86	52.04	95	1786	98	17.83	34.65	136	1521	208	0	83.0
AP CHK SUS HYB#3	256	359.6	103	11742	100	0.86	57.69	106	1871	102	18.84	32.88	119	1486	231	0	83.1
Comm Benchmark Mean		348.6		11748		0.95	54.58		1830		18.37	33.86	131	1592	262		84.9
Comm Trial Mean		347.5		11937		0.90	54.28		1862		18.27	34.41	128	1554	237		80.0
Coeff. of Var. (%)		2.8		5.9		6.4	5.1		7.1		2.5	5.5	15	5.0	11		7.6
Mean LSD (0.05)		12.2		893		0.07	3.49		166		0.58	2.46	24	89	30		7.2
Mean LSD (0.01)		16.1		1180		0.09	4.61		219		0.77	3.25	31	117	40		9.5
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from East Grand — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188309

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 18. 2018 Performance of Varieties - ACSC Experimental RR Official Trial
Stephen MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	377.2	99	9907	97	0.85	62.78	99	1650	97	19.70	26.22	158	1413	221	0	91.4
BTS 8337	119	384.1	101	10403	102	0.75	64.75	102	1756	103	19.95	27.04	145	1291	183	0	84.1
BTS 8500	124	380.0	100	11051	108	0.79	63.59	100	1845	108	19.79	29.17	161	1321	205	0	93.7
BTS 8524	127	371.1	98	11424	112	0.88	61.03	96	1877	110	19.43	30.84	170	1519	217	0	85.2
BTS 8606	106	382.1	101	10427	102	0.79	64.20	101	1750	103	19.91	27.29	147	1390	192	0	85.3
BTS 8629	110	374.7	99	10994	108	0.79	62.06	98	1822	107	19.52	29.34	188	1322	194	0	79.4
Crystal 093RR	126	385.0	101	10223	100	0.84	65.02	103	1726	101	20.09	26.56	144	1368	238	0	91.4
Crystal 247RR	113	381.1	100	10628	104	0.76	63.90	101	1779	104	19.81	27.94	166	1378	160	0	88.8
Crystal 355RR	109	381.0	100	9266	91	0.85	63.87	101	1553	91	19.89	24.34	149	1415	226	0	93.6
Crystal 467RR	120	378.0	100	11167	110	0.85	63.02	99	1860	109	19.75	29.57	222	1444	191	0	89.7
Crystal 572RR	112	381.3	100	10886	107	0.77	63.96	101	1823	107	19.84	28.63	141	1267	212	0	89.0
Crystal 573RR	101	388.6	102	11071	109	0.79	66.06	104	1883	110	20.23	28.46	132	1361	206	0	93.1
Crystal 574RR	114	377.0	99	11266	111	0.79	62.74	99	1874	110	19.64	29.87	151	1297	210	0	91.3
Crystal 578RR	115	380.6	100	10642	104	0.79	63.75	101	1785	105	19.82	27.92	157	1383	189	0	91.0
Hilleshög HM4302RR	107	365.9	96	10150	100	0.77	59.54	94	1648	97	19.06	27.82	173	1374	167	0	83.8
Hilleshög HM4448RR	125	386.1	102	11205	110	0.78	65.33	103	1895	111	20.09	29.05	147	1338	200	0	90.1
Hilleshög HM9528RR	117	372.5	98	10119	99	0.77	61.45	97	1668	98	19.39	27.18	164	1300	192	0	78.7
Hilleshög HIL9708	131	382.0	101	10696	105	0.74	64.16	101	1796	105	19.84	28.03	147	1308	176	0	89.6
Maribo MA109	128	382.1	101	9133	90	0.77	64.19	101	1533	90	19.88	23.95	151	1363	183	0	80.2
Maribo MA305	102	381.1	100	10538	103	0.83	63.90	101	1761	103	19.88	27.78	203	1381	202	0	77.4
Maribo MA502	116	370.7	98	9966	98	0.86	60.91	96	1638	96	19.39	26.86	261	1436	186	0	84.7
Maribo MA504	122	368.5	97	10809	106	0.86	60.28	95	1768	104	19.28	29.34	208	1419	216	0	89.5
SX Avalanche RR	129	386.7	102	10820	106	0.74	65.50	103	1834	108	20.08	27.94	147	1359	162	0	83.3
SX Bronco RR(1863)	105	381.5	101	10688	105	0.75	64.03	101	1788	105	19.82	28.15	143	1333	173	0	83.0
SX Canyon RR	103	377.7	100	10808	106	0.77	62.91	99	1800	106	19.65	28.65	130	1388	183	0	87.3
SX Cruze RR	121	358.6	95	10683	105	0.83	57.46	91	1711	100	18.76	29.83	171	1380	215	0	69.2
SX Marathon RR	111	372.1	98	11037	108	0.75	61.33	97	1819	107	19.35	29.69	139	1343	173	0	91.0
SV RR265	108	362.5	96	10689	105	0.73	58.58	92	1726	101	18.86	29.49	158	1323	161	0	86.9
SV RR266	118	373.5	98	10451	103	0.75	61.72	97	1724	101	19.43	28.05	133	1368	172	0	79.6
SV RR268	132	382.8	101	10704	105	0.73	64.40	102	1800	106	19.87	27.99	128	1383	155	0	81.1
SV RR333	123	377.5	99	10363	102	0.77	62.87	99	1724	101	19.65	27.49	151	1360	180	0	79.8
SV RR351	104	367.5	97	10615	104	0.74	60.01	95	1734	102	19.11	28.88	147	1356	159	0	84.4
Crystal 101RR (Check)	133	378.2	100	10914	107	0.81	63.08	99	1825	107	19.72	28.73	180	1443	176	0	90.4
BTS 8572 (Check)	134	381.4	101	10666	105	0.78	63.99	101	1791	105	19.84	27.96	132	1306	206	0	89.6
ACFILL #41	135	361.2	95	9911	97	0.76	58.20	92	1597	94	18.82	27.42	162	1318	177	0	90.2
ACFILL #42	136	362.5	96	10135	99	0.90	58.58	92	1639	96	19.03	27.91	219	1473	228	0	87.5

Experimental Trial (Comm status)																	
BTS 8735	250	396.0	104	10981	108	0.78	68.14	107	1880	110	20.58	27.83	178	1232	211	0	90.1
BTS 8749	243	386.5	102	10018	98	0.76	65.41	103	1694	99	20.08	26.04	137	1388	173	0	90.7
BTS 8767	225	384.7	101	10953	108	0.77	64.92	102	1845	108	20.00	28.52	144	1377	176	0	92.4
BTS 8784	210	391.1	103	10399	102	0.72	66.72	105	1776	104	20.27	26.60	124	1210	192	0	89.0
BTS 8815	211	389.9	103	10753	106	0.78	66.41	105	1835	108	20.27	27.52	152	1376	186	0	88.0
BTS 8826	245	396.9	105	9787	96	0.87	68.38	108	1682	99	20.70	24.73	140	1390	249	0	88.8
BTS 8839	232	381.8	101	10787	106	0.72	64.10	101	1806	106	19.80	28.18	142	1223	182	0	95.4
BTS 8844	205	394.2	104	10343	102	0.72	67.63	107	1773	104	20.43	26.26	127	1311	161	0	88.8
BTS 8857	235	386.5	102	9118	89	0.75	65.42	103	1542	90	20.07	23.74	106	1271	202	0	84.4
BTS 8864	224	392.8	104	10474	103	0.78	67.20	106	1798	105	20.41	26.51	105	1315	210	0	81.2
BTS 8882	229	375.2	99	10853	107	0.84	62.23	98	1797	105	19.60	28.86	198	1416	198	0	82.2
BTS 8891	226	388.0	102	9968	98	0.74	65.85	104	1700	100	20.16	25.46	137	1261	193	0	88.3
Crystal 684RR	227	377.0	99	11797	116	0.85	62.74	99	1965	115	19.70	31.22	182	1391	222	0	88.7
Crystal 792RR	240	384.5	101	11072	109	0.77	64.86	102	1866	109	19.98	28.72	127	1292	206	0	86.7
Crystal 793RR	238	393.0	104	11974	118	0.71	67.28	106	2044	120	20.35	30.53	129	1219	175	0	87.3
Crystal 796RR	231	380.4	100	11242	110	0.81	63.72	100	1871	110	19.81	29.79	144	1319	223	0	91.9
Crystal 802RR	207	388.5	102	10452	103	0.75	66.02	104	1770	104	20.17	27.01	125	1259	201	0	89.3
Crystal 803RR	244	379.5	100	11180	110	0.83	63.45	100	1870	110	19.80	29.47	151	1360	219	0	95.4
Crystal 804RR	246	384.7	101	11342	111	0.81	64.92	102	1906	112	20.04	29.58	183	1328	200	0	92.4
Crystal 807RR	215	384.1	101	11319	111	0.78	64.76	102	1905	112	19.99	29.42	222	1335	168	0	81.2
Crystal 808RR	218	385.7	102	11897	117	0.77	65.20	103	2015	118	20.04	30.66	165	1337	178	0	92.5
Crystal 809RR	214	395.5	104	10078	99	0.76	67.99	107	1732	102	20.53	25.46	146	1344	174	0	90.2
Hilleshög HIL2230	221	371.4	98	10332	101	0.74	61.15	96	1708	100	19.30	27.74	150	1303	171	0	89.1
Hilleshög HIL2231	208	370.4	98	9136	90	0.82	60.84	96	1502	88	19.32	24.60	187	1414	188	0	81.0
Hilleshög HIL2232	203	387.2	102	10150	100	0.80	65.65	103	1721	101	20.16	26.11	164	1355	200	0	90.4
Hilleshög HIL2233	209	382.8	101	10886	107	0.79	64.39	102	1821	107	19.91	28.61	161	1299	205	0	87.0
Hilleshög HIL2234	217	377.3	99	10412	102	0.78	62.81	99	1729	101	19.65	27.59	169	1382	173	0	88.8
Hilleshög HIL2235	247	381.1	100	10577	104	0.86	63.90	101	1770	104	19.89	27.78	194	1469	197	0	87.4
Hilleshög HIL2236	213	383.8	101	9982	98	0.76	64.67	102	1692	99	19.95	25.72	155	1306	181	0	91.2
Hilleshög HIL9920	223	388.9	102	11149	109	0.74	66.12	104	1898	111	20.18	28.66	155	1332	163	0	91.9
Maribo MA717	248	395.3	104	10733	105	0.77	67.94	107	1849	108	20.53	27.09	145	1346	182	0	92.4
Maribo MA808	234	376.0	99	8702	85	0.79	62.45	98	1441	85	19.57	23.19	221	1410	150	0	91.3
Maribo MA809	233	370.4	98	10734	105	0.80	60.87	96	1763	103	19.32	29.03	222	1424	157	0	86.6
Maribo MA810	220	377.9	100	9660	95	0.91	62.99	99	1610	94	19.81	25.48	203	1444	240	0	80.2
Maribo MA811	206	384.2	101	9937	98	0.79	64.77	102	1675	98	19.99	25.83	196	1375	175	0	79.2
Maribo MA812	222	388.3	102	9880	97	0.71	65.94	104	1673	98	20.10	25.55	136	1216	168	0	90.4
SX RR1879	219	377.3	99	10632	104	0.71	62.82	99	1765	104	19.57	28.25	124	1243	170	0	91.0
SX 1885	212	372.4	98	10170	100	0.77	61.42	97	1684	99	19.39	27.15	145	1346	185	0	81.2
SX 1886	239	375.8	99	11047	108	0.76	62.41	98	1841	108	19.55	29.15	135	1341	183	0	81.6
SX 1887	241	381.3	100	11202	110	0.74	63.97	101	1881	110	19.81	29.27	124	1368	166	0	82.6
SX 1888	216	376.5	99	10992	108	0.70	62.59	99	1825	107	19.50	29.20	129	1262	151	0	84.1
SX 1889	249	375.6	99	9401	92	0.76	62.33	98	1564	92	19.54	24.87	169	1341	169	0	90.6
SV 284	228	374.3	99	9896	97	0.72	61.98	98	1635	96	19.42	26.61	168	1253	162	0	92.5
SV 285	201	376.6	99	10997	108	0.74	62.61	99	1825	107	19.56	29.23	126	1315	176	0	84.6
SV 286	236	384.0	101	10415	102	0.71	64.72	102	1761	103	19.90	27.02	130	1279	161	0	71.7
SV 287	242	373.6	98	10790	106	0.80	61.77	97	1780	104	19.47	28.92	128	1435	189	0	92.0
SV 288	230	379.7	100	11317	111	0.76	63.52	100	1895	111	19.73	29.82	136	1357	179	0	89.4
SV 289	237	382.3	101	11238	110	0.75	64.25	101	1881	110	19.85	29.50	138	1330	173	0	83.4
SV RR371	202	374.4	99	10760	106	0.72	62.02	98	1782	105	19.45	28.55	116	1350	154	0	88.2
SV RR375	204	371.7	98	10683	105	0.72	61.22	97	1756	103	19.31	28.82	131	1339	157	0	90.2
BTS 80RR52(Check)	251	378.5	100	10220	100	0.84	63.14	100	1706	100	19.75	27.06	149	1394	223	0	94.3
Crystal 101RR (Check)	252	379.0	100	10796	106	0.85	63.29	100	1806	106	19.80	28.44	199	1563	167	0	90.4
Crystal 355RR(Check)	253	381.1	100	9390	92	0.82	63.91	101	1575	92	19.87	24.51	144	1318	228	0	88.0
BTS 8572 (Check)	254	379.3	100	10347	102	0.78	63.38	100	1732	102	19.74	27.24	126	1301	211	0	89.8
AP CHK MOD RES RR	255	388.6	102	10951	107	0.72	66.04	104	1856	109	20.13	28.18	132	1327	151	0	86.2
AP CHK SUS HYB#3	256	383.3	101	10226	100	0.75	64.52	102	1723	101	19.93	26.64	172	1326	169	0	85.7
Comm Benchmark Mean		379.5		10188		0.82	63.43		1705		19.79	26.81	155	1394	207		90.6
Comm Trial Mean		376.5		10568		0.79	62.59		1756		19.62	28.09	162	1367	191		86.2
Coeff. of Var. (%)		2.4		5.4		6.4	4.2		6.1		2.3	5.3	18	4.8	12		6.2
Mean LSD (0.05)		11.5		726		0.06	3.29		136		0.57	1.90	36	83	29		6.1
Mean LSD (0.01)		15.2		959		0.08	4.35		179		0.75	2.51	47	109	38		8.1
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**
* 2018 Data from Stephen MN		Bolters per acre are based upon 45,000 plants per acre.													Created 11/2/2018		
@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial.															Trial # = 188310		
++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.																	

Table 19. 2018 Performance of Varieties - ACSC Experimental RR Official Trial
St Thomas ND

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	374.8	100	6161	91	1.28	62.10	100	1022	91	20.01	16.40	172	1506	529	0	85.7
BTS 8337	119	389.4	104	7110	105	1.14	66.29	106	1207	107	20.64	18.34	141	1514	431	0	81.1
BTS 8500	124	387.1	103	7836	115	1.06	65.63	105	1327	118	20.41	20.26	155	1464	376	0	85.7
BTS 8524	127	369.7	98	7784	115	1.18	60.64	97	1277	113	19.68	21.06	194	1631	409	0	75.0
BTS 8606	106	390.9	104	7549	111	1.12	66.70	107	1290	114	20.66	19.27	179	1465	416	0	79.5
BTS 8629	110	382.4	102	8300	122	1.17	64.27	103	1396	124	20.30	21.69	210	1391	459	0	69.8
Crystal 093RR	126	391.6	104	7178	106	1.10	66.90	107	1227	109	20.67	18.32	151	1469	409	0	82.4
Crystal 247RR	113	378.3	101	7400	109	1.11	63.11	101	1232	109	20.02	19.59	183	1505	396	0	79.3
Crystal 355RR	109	376.0	100	6312	93	1.27	62.45	100	1049	93	20.06	16.77	217	1582	488	0	89.4
Crystal 467RR	120	373.7	100	7291	107	1.18	61.80	99	1205	107	19.85	19.49	269	1618	390	0	85.0
Crystal 572RR	112	385.6	103	7446	110	1.07	65.19	105	1256	111	20.35	19.37	146	1416	398	0	80.5
Crystal 573RR	101	395.5	105	7565	111	1.05	68.02	109	1301	115	20.83	19.14	138	1418	384	0	84.6
Crystal 574RR	114	378.4	101	7911	116	1.20	63.12	101	1317	117	20.10	20.94	191	1516	461	0	84.5
Crystal 578RR	115	384.2	102	7438	109	1.19	64.80	104	1254	111	20.40	19.38	194	1532	439	0	86.4
Hilleshög HM4302RR	107	380.1	101	7084	104	1.10	63.63	102	1185	105	20.11	18.67	166	1553	377	0	76.3
Hilleshög HM4448RR	125	389.0	104	7681	113	1.18	66.15	106	1308	116	20.62	19.71	164	1474	466	0	80.2
Hilleshög HM9528RR	117	377.3	101	7303	107	1.17	62.82	101	1216	108	20.05	19.38	179	1523	435	0	75.3
Hilleshög HIL9708	131	370.1	99	7124	105	1.26	60.76	98	1168	104	19.80	19.29	201	1508	507	0	76.8
Maribo MA109	128	393.5	105	6659	98	1.24	67.46	108	1138	101	20.91	17.01	181	1525	480	0	77.3
Maribo MA305	102	379.8	101	7527	111	1.08	63.53	102	1259	112	20.10	19.82	202	1447	383	0	67.7
Maribo MA502	116	365.3	97	6876	101	1.23	59.37	95	1117	99	19.49	18.83	273	1584	432	0	76.2
Maribo MA504	122	381.3	102	7331	108	1.29	63.95	103	1229	109	20.35	19.25	226	1577	492	0	77.3
SX Avalanche RR	129	377.2	100	6977	103	0.96	62.80	101	1161	103	19.84	18.50	172	1539	275	20	74.4
SX Bronco RR(1863)	105	389.9	104	7702	113	1.09	66.43	107	1313	116	20.56	19.75	161	1550	370	0	75.8
SX Canyon RR	103	379.2	101	7450	110	1.09	63.37	102	1247	111	20.08	19.61	165	1583	366	0	79.8
SX Cruze RR	121	336.5	90	5995	88	1.66	51.11	82	909	81	18.50	17.86	285	1705	730	0	49.9
SX Marathon RR	111	377.3	101	7558	111	1.27	62.81	101	1258	112	20.12	20.04	177	1617	486	0	80.6
SV RR265	108	372.7	99	7252	107	1.17	61.50	99	1195	106	19.80	19.47	158	1539	434	0	80.2
SV RR266	118	379.7	101	7336	108	1.14	63.50	102	1228	109	20.13	19.29	149	1517	430	0	69.3
SV RR268	132	384.0	102	7851	116	1.10	64.73	104	1323	117	20.27	20.44	163	1584	374	0	77.3
SV RR333	123	384.4	102	7388	109	1.18	64.86	104	1246	110	20.40	19.23	168	1603	429	0	69.8
SV RR351	104	379.7	101	7768	114	1.14	63.49	102	1298	115	20.12	20.47	175	1543	415	0	78.5
Crystal 101RR (Check)	133	373.5	100	7608	112	1.22	61.73	99	1257	111	19.89	20.38	222	1645	426	0	79.4
BTS 8572 (Check)	134	377.2	100	7094	104	1.22	62.77	101	1183	105	20.08	18.76	158	1495	487	0	71.8
ACFILL #41	135	369.3	98	7046	104	1.07	60.51	97	1156	103	19.53	19.06	167	1447	386	0	80.4
ACFILL #42	136	360.2	96	6364	94	1.57	57.92	93	1022	91	19.58	17.69	280	1690	664	0	72.2

Experimental Trial (Comm status)																	
BTS 8735	250	392.2	104	6991	103	1.19	67.11	108	1201	106	20.82	17.78	218	1396	474	0	80.9
BTS 8749	243	371.7	99	6193	91	1.27	61.19	98	1020	90	19.84	16.64	157	1608	497	0	80.1
BTS 8767	225	379.3	101	6932	102	1.19	63.40	102	1164	103	20.17	18.17	183	1582	441	0	82.7
BTS 8784	210	380.4	101	6733	99	1.20	63.71	102	1132	100	20.21	17.62	144	1425	503	0	87.8
BTS 8815	211	382.8	102	6962	102	1.14	64.39	103	1175	104	20.25	18.09	186	1518	421	0	80.2
BTS 8826	245	379.1	101	5695	84	1.39	63.32	102	954	85	20.36	15.01	220	1571	576	0	74.8
BTS 8839	232	384.4	102	6795	100	1.09	64.83	104	1149	102	20.28	17.62	135	1305	452	0	86.3
BTS 8844	205	383.0	102	6651	98	1.29	64.44	104	1125	100	20.43	17.27	238	1572	496	0	79.7
BTS 8857	235	379.1	101	5673	84	1.04	63.33	102	951	84	20.00	14.89	140	1461	372	0	78.0
BTS 8864	224	379.6	101	6361	94	1.15	63.49	102	1067	95	20.12	16.66	154	1420	460	0	71.7
BTS 8882	229	382.6	102	8280	122	1.11	64.35	103	1396	124	20.24	21.58	167	1452	416	0	75.4
BTS 8891	226	394.4	105	6959	102	1.20	67.73	109	1200	106	20.90	17.57	164	1510	470	0	85.5
Crystal 684RR	227	377.7	101	7413	109	1.20	62.94	101	1239	110	20.08	19.55	212	1561	443	0	83.0
Crystal 792RR	240	372.8	99	6628	98	1.19	61.51	99	1095	97	19.85	17.78	141	1489	472	0	80.5
Crystal 793RR	238	382.6	102	7148	105	1.13	64.35	103	1210	107	20.26	18.56	152	1377	456	0	78.9
Crystal 796RR	231	377.4	101	7894	116	1.09	62.85	101	1318	117	19.96	20.84	168	1529	385	0	82.9
Crystal 802RR	207	375.7	100	6447	95	1.23	62.34	100	1072	95	20.01	17.11	165	1435	516	0	76.4
Crystal 803RR	244	385.9	103	6892	101	1.03	65.26	105	1169	104	20.30	17.82	134	1456	368	0	88.2
Crystal 804RR	246	381.1	102	7531	111	1.18	63.92	103	1269	112	20.21	19.67	230	1392	467	0	72.3
Crystal 807RR	215	374.8	100	6926	102	1.07	62.08	100	1152	102	19.79	18.39	196	1602	338	0	65.2
Crystal 808RR	218	378.7	101	7227	106	1.31	63.22	102	1208	107	20.23	19.06	249	1567	504	0	82.6
Crystal 809RR	214	383.4	102	6471	95	1.20	64.54	104	1094	97	20.35	16.81	197	1541	451	0	81.5
Hilleshög HIL2230	221	374.4	100	7189	106	1.25	61.99	100	1196	106	19.97	19.09	225	1540	477	0	80.3
Hilleshög HIL2231	208	372.0	99	6393	94	1.29	61.27	98	1055	94	19.87	17.16	256	1783	435	0	70.7
Hilleshög HIL2232	203	383.2	102	6133	90	1.23	64.49	104	1037	92	20.40	15.92	195	1609	456	0	83.2
Hilleshög HIL2233	209	382.5	102	7182	106	1.17	64.30	103	1209	107	20.28	18.73	186	1451	451	0	86.5
Hilleshög HIL2234	217	380.2	101	6912	102	1.04	63.67	102	1160	103	20.03	18.08	190	1533	338	0	79.2
Hilleshög HIL2235	247	372.6	99	6836	101	1.37	61.46	99	1131	100	20.01	18.29	208	1579	567	60	72.9
Hilleshög HIL2236	213	381.9	102	6877	101	1.15	64.14	103	1156	102	20.23	18.01	176	1383	466	0	85.2
Hilleshög HIL9920	223	384.1	102	7154	105	1.17	64.76	104	1213	108	20.34	18.50	197	1560	425	0	84.0
Maribo MA717	248	383.2	102	6989	103	1.32	64.49	104	1182	105	20.43	18.11	254	1504	533	0	77.8
Maribo MA808	234	364.3	97	5925	87	1.22	59.06	95	961	85	19.49	16.30	237	1717	406	0	75.0
Maribo MA809	233	365.4	97	6991	103	1.19	59.40	95	1139	101	19.45	19.09	241	1582	415	0	76.0
Maribo MA810	220	378.4	101	6311	93	1.28	63.12	101	1057	94	20.17	16.58	244	1594	486	0	59.7
Maribo MA811	206	369.6	98	7050	104	1.41	60.58	97	1160	103	19.88	18.99	258	1671	553	0	66.0
Maribo MA812	222	383.2	102	6329	93	1.16	64.49	104	1068	95	20.31	16.48	173	1399	464	0	86.5
SX RR1879	219	376.1	100	7340	108	1.13	62.47	100	1222	108	19.96	19.48	143	1472	433	0	84.4
SX 1885	212	366.3	98	7047	104	1.31	59.64	96	1153	102	19.69	19.18	182	1611	522	0	74.0
SX 1886	239	378.3	101	7188	106	1.15	63.10	101	1203	107	20.05	18.94	146	1583	424	0	75.3
SX 1887	241	374.9	100	7315	108	1.25	62.11	100	1218	108	19.97	19.42	171	1607	479	0	75.8
SX 1888	216	380.4	101	7094	104	1.22	63.72	102	1191	106	20.25	18.61	152	1574	470	0	72.4
SX 1889	249	374.8	100	6351	93	1.08	62.10	100	1057	94	19.83	16.87	277	1536	338	0	88.1
SV 284	228	379.5	101	6793	100	1.11	63.45	102	1139	101	20.11	17.86	203	1571	371	0	83.4
SV 285	201	374.7	100	7079	104	1.22	62.06	100	1175	104	19.94	18.82	148	1558	476	0	75.2
SV 286	236	378.7	101	7240	107	1.25	63.22	102	1214	108	20.16	19.02	177	1554	493	0	70.2
SV 287	242	370.5	99	7246	107	1.33	60.83	98	1189	105	19.80	19.51	229	1641	519	0	74.7
SV 288	230	373.3	99	7726	114	1.15	61.65	99	1277	113	19.82	20.68	175	1466	440	0	83.1
SV 289	237	381.2	102	7443	110	1.20	63.95	103	1253	111	20.26	19.42	171	1608	440	0	85.6
SV RR371	202	374.6	100	6885	101	1.18	62.03	100	1141	101	19.91	18.34	176	1571	437	0	71.3
SV RR375	204	370.7	99	7193	106	1.21	60.89	98	1188	105	19.72	19.30	170	1601	451	0	85.7
BTS 80RR52(Check)	251	372.8	99	6006	88	1.32	61.52	99	992	88	19.94	16.07	192	1573	535	0	87.1
Crystal 101RR (Check)	252	373.4	99	7449	110	1.27	61.69	99	1227	109	19.93	20.01	257	1614	465	0	82.2
Crystal 355RR(Check)	253	373.6	100	6958	102	1.33	61.74	99	1156	102	20.02	18.53	179	1603	542	0	86.2
BTS 8572 (Check)	254	381.7	102	6762	100	1.06	64.09	103	1137	101	20.15	17.70	140	1438	388	0	77.7
AP CHK MOD RES RR	255	387.8	103	7231	106	1.17	65.83	106	1229	109	20.56	18.64	208	1513	429	0	85.5
AP CHK SUS HYB#3	256	378.5	101	6356	94	1.19	63.17	101	1066	95	20.13	16.72	222	1523	435	0	74.5
Comm Benchmark Mean		375.4		6794		1.25	62.26		1128		20.01	18.08	192	1557	482		83.3
Comm Trial Mean		378.7		7285		1.18	63.23		1216		20.12	19.24	187	1535	440		77.7
Coeff. of Var. (%)		2.4		5.5		9.4	4.2		6.3		2.1	5.2	24	4.7	16		7.9
Mean LSD (0.05)		11.8		513		0.14	3.37		98		0.53	1.27	53	88	90		7.4
Mean LSD (0.01)		15.5		677		0.19	4.45		130		0.70	1.68	70	117	118		9.8
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from St Thomas ND — Bolters per acre are based upon 45,000 plants per acre. — Created 11/2/2018

@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial. — Trial # = 188311

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 20. 2018 Performance of Varieties - ACSC Experimental RR Official Trial

Bathgate MN

Description @	Code	Rec/T lbs.	Rec/T %Bnch	Rec/A lbs.	Rec/A %Bnch	Loss Mol %	Rev/T $ ++	Rev/T %Bnch	Rev/A $ ++	Rev/A %Bnch	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter per Ac	Emerg. %
Commercial Trial																	
BTS 80RR52	130	364.0	100	8484	95	1.07	58.99	100	1370	95	19.26	23.36	136	1645	340	0	91.2
BTS 8337	119	372.6	102	8718	98	0.99	61.47	104	1438	100	19.62	23.38	118	1529	321	0	87.3
BTS 8500	124	366.2	101	9649	108	0.98	59.64	101	1564	109	19.30	26.38	127	1564	300	0	93.3
BTS 8524	127	350.4	96	9748	109	1.09	55.12	93	1534	106	18.60	27.81	146	1769	319	0	84.1
BTS 8606	106	367.3	101	9687	109	0.96	59.96	102	1585	110	19.32	26.24	128	1550	283	0	89.4
BTS 8629	110	358.7	99	9647	108	0.97	57.50	97	1535	107	18.91	27.17	125	1443	322	0	77.9
Crystal 093RR	126	368.3	101	8843	99	1.07	60.24	102	1447	100	19.48	24.02	118	1604	359	0	92.4
Crystal 247RR	113	363.8	100	9395	105	0.98	58.96	100	1527	106	19.17	25.71	136	1588	292	0	92.2
Crystal 355RR	109	372.6	102	8450	95	1.00	61.46	104	1387	96	19.63	22.74	106	1557	326	0	95.3
Crystal 467RR	120	364.6	100	8864	99	1.07	59.17	100	1444	100	19.29	24.23	168	1719	311	0	87.2
Crystal 572RR	112	370.1	102	9097	102	1.02	60.74	103	1496	104	19.53	24.64	116	1521	344	0	84.6
Crystal 573RR	101	361.9	99	9079	102	1.02	58.40	99	1461	101	19.11	25.11	121	1508	345	0	92.7
Crystal 574RR	114	359.7	99	9755	109	1.03	57.78	98	1558	108	19.01	27.24	138	1554	332	0	87.4
Crystal 578RR	115	366.8	101	9408	105	0.98	59.79	101	1538	107	19.31	25.53	122	1583	293	0	91.4
Hilleshög HM4302RR	107	367.8	101	9163	103	0.97	60.09	102	1498	104	19.35	24.95	142	1623	266	0	86.2
Hilleshög HM4448RR	125	373.5	103	9730	109	0.88	61.71	105	1605	111	19.56	26.12	104	1425	266	0	89.1
Hilleshög HM9528RR	117	364.8	100	9395	105	0.94	59.23	100	1534	106	19.20	25.64	119	1501	291	20	85.2
Hilleshög HIL9708	131	365.7	100	9023	101	0.99	59.49	101	1467	102	19.29	24.67	117	1585	308	0	90.9
Maribo MA109	128	373.8	103	8505	95	0.96	61.82	105	1406	98	19.65	22.76	129	1563	285	0	79.9
Maribo MA305	102	360.0	99	9287	104	0.99	57.85	98	1488	103	18.99	25.87	126	1495	326	0	84.1
Maribo MA502	116	352.8	97	8311	93	1.13	55.78	94	1305	91	18.77	23.76	168	1751	346	0	92.4
Maribo MA504	122	361.3	99	9746	109	1.02	58.22	99	1578	110	19.09	26.86	133	1595	320	0	91.4
SX Avalanche RR	129	356.8	98	8319	93	1.03	56.94	96	1326	92	18.87	23.46	143	1623	318	0	86.7
SX Bronco RR(1863)	105	364.8	100	8954	100	0.99	59.23	100	1456	101	19.23	24.47	131	1576	301	0	88.9
SX Canyon RR	103	362.8	100	9741	109	1.03	58.66	99	1573	109	19.16	26.90	121	1615	326	20	87.0
SX Cruze RR	121	336.5	92	8830	99	1.16	51.13	87	1340	93	17.99	26.35	147	1711	394	0	55.2
SX Marathon RR	111	363.4	100	9130	102	0.98	58.83	100	1477	103	19.15	25.20	122	1599	288	0	88.0
SV RR265	108	354.9	97	9311	104	0.98	56.38	95	1473	102	18.71	26.41	129	1580	291	0	88.8
SV RR266	118	362.9	100	9161	103	0.99	58.68	99	1477	103	19.14	25.22	135	1626	287	0	80.2
SV RR268	132	367.7	101	9140	102	0.97	60.07	102	1483	103	19.36	25.02	117	1580	289	0	85.1
SV RR333	123	371.3	102	8870	99	0.94	61.10	103	1459	101	19.50	23.94	111	1563	270	0	82.8
SV RR351	104	365.6	100	9319	104	0.99	59.46	101	1507	105	19.27	25.64	107	1559	314	0	86.0
Crystal 101RR (Check)	133	352.1	97	9526	107	1.05	55.59	94	1497	104	18.65	27.29	152	1741	294	0	90.2
BTS 8572 (Check)	134	367.9	101	9216	103	0.98	60.11	102	1509	105	19.37	25.05	111	1493	324	0	89.6
ACFILL #41	135	349.1	96	8799	99	0.93	54.75	93	1376	96	18.39	25.21	132	1510	272	0	88.2
ACFILL #42	136	359.8	99	8034	90	1.14	57.79	98	1290	90	19.13	22.32	150	1721	370	0	84.4

Experimental Trial (Comm status)																	
BTS 8735	250	378.6	104	9439	106	0.88	63.16	107	1571	109	19.81	25.06	115	1383	273	0	93.8
BTS 8749	243	365.9	100	8950	100	1.02	59.52	101	1454	101	19.31	24.39	115	1615	322	0	87.5
BTS 8767	225	365.8	100	9783	110	0.99	59.48	101	1595	111	19.27	26.55	136	1649	278	0	94.4
BTS 8784	210	382.1	105	9551	107	0.88	64.14	109	1609	112	19.98	24.89	105	1420	265	0	87.0
BTS 8815	211	369.9	102	9485	106	0.90	60.69	103	1559	108	19.41	25.77	121	1555	240	0	91.4
BTS 8826	245	368.8	101	8470	95	1.14	60.36	102	1397	97	19.55	22.61	128	1668	391	0	91.9
BTS 8839	232	374.3	103	8764	98	0.95	61.93	105	1466	102	19.65	23.24	110	1481	302	0	97.9
BTS 8844	205	377.3	104	8412	94	0.91	62.78	106	1412	98	19.78	22.38	121	1579	245	0	91.8
BTS 8857	235	372.0	102	8172	92	0.94	61.27	104	1346	93	19.54	22.19	107	1509	289	0	85.7
BTS 8864	224	377.2	104	8709	98	0.95	62.76	106	1445	100	19.81	23.14	108	1522	294	0	82.4
BTS 8882	229	370.4	102	9951	112	0.96	60.81	103	1646	114	19.48	26.71	131	1630	265	0	79.3
BTS 8891	226	374.5	103	9323	105	1.00	61.96	105	1558	108	19.71	24.67	124	1530	327	0	92.5
Crystal 684RR	227	363.9	100	10316	116	1.02	58.95	100	1671	116	19.21	28.38	129	1663	302	0	95.7
Crystal 792RR	240	370.0	102	9440	106	0.97	60.71	103	1558	108	19.47	25.35	110	1526	306	0	85.9
Crystal 793RR	238	372.4	102	10077	113	0.89	61.39	104	1675	116	19.51	26.94	102	1426	270	60	89.5
Crystal 796RR	231	363.0	100	10338	116	0.97	58.70	99	1677	116	19.11	28.49	119	1587	284	0	91.1
Crystal 802RR	207	377.9	104	9861	111	0.92	62.96	107	1665	116	19.81	25.85	100	1405	302	0	84.1
Crystal 803RR	244	372.6	102	9960	112	0.95	61.43	104	1653	115	19.57	26.70	117	1494	301	0	95.4
Crystal 804RR	246	364.6	100	10216	115	0.97	59.16	100	1660	115	19.20	28.06	135	1550	295	0	86.7
Crystal 807RR	215	371.7	102	9608	108	0.91	61.17	104	1606	111	19.50	25.76	125	1547	248	0	81.7
Crystal 808RR	218	365.7	100	10060	113	0.99	59.45	101	1658	115	19.28	27.53	131	1579	299	0	91.9
Crystal 809RR	214	371.5	102	9135	102	0.97	61.14	104	1504	104	19.53	24.48	121	1615	277	0	95.6
Hilleshög HIL2230	221	372.7	102	9159	103	0.99	61.46	104	1520	105	19.60	24.37	136	1534	307	0	94.5
Hilleshög HIL2231	208	360.0	99	7704	86	1.05	57.87	98	1226	85	19.04	21.42	160	1707	305	0	83.5
Hilleshög HIL2232	203	373.2	102	8541	96	0.96	61.59	104	1412	98	19.62	23.05	124	1594	275	0	94.0
Hilleshög HIL2233	209	369.0	101	9778	110	0.93	60.41	102	1628	113	19.37	26.10	113	1448	292	0	89.0
Hilleshög HIL2234	217	365.4	100	9192	103	0.93	59.37	101	1508	105	19.19	24.99	133	1592	253	0	92.6
Hilleshög HIL2235	247	362.7	100	8389	94	1.17	58.62	99	1360	94	19.30	23.07	149	1682	403	0	90.6
Hilleshög HIL2236	213	376.1	103	8964	101	0.90	62.41	106	1489	103	19.70	24.03	108	1446	276	0	92.7
Hilleshög HIL9920	223	383.1	105	9181	103	0.90	64.40	109	1548	107	20.05	23.93	118	1526	250	0	90.6
Maribo MA717	248	372.0	102	9370	105	0.92	61.26	104	1560	108	19.51	24.96	124	1520	260	0	97.4
Maribo MA808	234	358.8	99	8014	90	1.01	57.50	97	1299	90	18.95	22.31	149	1760	261	0	92.2
Maribo MA809	233	356.6	98	9891	111	0.99	56.88	96	1566	109	18.80	27.70	155	1650	270	0	91.4
Maribo MA810	220	365.0	100	8262	93	1.14	59.26	100	1334	93	19.38	22.71	157	1722	371	0	79.3
Maribo MA811	206	367.9	101	9227	103	0.95	60.12	102	1520	106	19.35	25.04	132	1623	257	0	76.2
Maribo MA812	222	378.3	104	8406	94	0.87	63.06	107	1426	99	19.78	21.82	113	1405	258	0	97.7
SX RR1879	219	368.0	101	9338	105	0.90	60.14	102	1518	105	19.31	25.62	116	1586	234	0	95.4
SX 1885	212	374.6	103	9558	107	0.96	61.99	105	1575	109	19.67	25.55	110	1616	276	0	81.7
SX 1886	239	364.1	100	8904	100	0.98	59.01	100	1445	100	19.19	24.50	123	1628	285	0	87.8
SX 1887	241	364.4	100	9574	107	0.91	59.11	100	1551	108	19.13	26.29	123	1552	251	60	83.7
SX 1888	216	367.0	101	9815	110	0.96	59.87	101	1609	112	19.31	26.58	114	1568	282	0	83.7
SX 1889	249	371.2	102	8379	94	0.92	61.04	103	1395	97	19.48	22.36	136	1543	256	0	92.6
SV 284	228	369.2	101	8868	99	0.95	60.47	102	1440	100	19.42	24.34	133	1555	274	0	88.4
SV 285	201	368.0	101	9467	106	0.93	60.13	102	1551	108	19.33	25.70	117	1591	255	0	89.8
SV 286	236	364.9	100	9082	102	0.94	59.24	100	1481	103	19.19	24.88	116	1522	285	0	83.6
SV 287	242	364.8	100	9365	105	0.92	59.21	100	1534	107	19.17	25.64	109	1585	254	0	90.6
SV 288	230	364.7	100	9782	110	0.97	59.18	100	1569	109	19.20	27.01	111	1591	291	0	85.8
SV 289	237	366.1	101	9672	108	0.98	59.59	101	1567	109	19.28	26.58	128	1621	279	0	89.8
SV RR371	202	362.4	100	9305	104	0.97	58.53	99	1504	104	19.07	25.56	123	1547	295	0	92.5
SV RR375	204	367.3	101	9249	104	0.93	59.93	102	1517	105	19.30	25.13	117	1585	260	0	89.9
BTS 80RR52(Check)	251	367.7	101	8495	95	1.05	60.07	102	1388	96	19.45	23.24	115	1617	346	0	83.3
Crystal 101RR (Check)	252	352.5	97	9412	106	1.08	55.72	94	1474	102	18.70	26.93	155	1777	313	0	90.6
Crystal 355RR(Check)	253	366.3	101	8181	92	1.03	59.64	101	1324	92	19.34	22.48	133	1565	335	0	96.5
BTS 8572 (Check)	254	370.1	102	9588	108	0.93	60.73	103	1577	109	19.43	25.79	102	1477	290	0	90.3
AP CHK MOD RES RR	255	350.9	96	9157	103	0.87	55.27	94	1444	100	18.41	26.23	117	1445	248	0	94.6
AP CHK SUS HYB#3	256	375.3	103	8949	100	0.95	62.19	105	1491	103	19.70	23.58	144	1540	272	0	84.7
Comm Benchmark Mean		364.2		8919		1.03	59.04		1441		19.23	24.61	126	1609	321		90.2
Comm Trial Mean		362.8		9120		1.01	58.67		1472		19.15	25.19	129	1588	312		86.9
Coeff. of Var. (%)		3.1		5.8		7.7	5.4		7.3		2.7	5.1	15	4.5	15		6.7
Mean LSD (0.05)		13.9		667		0.10	3.98		134		0.64	1.65	23	89	58		6.6
Mean LSD (0.01)		18.3		881		0.13	5.25		177		0.84	2.19	31	118	77		8.8
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**
* 2018 Data from Bathgate MN		Bolters per acre are based upon 45,000 plants per acre.													Created 11/2/2018		
@ Experimental trial data adjusted to commercial status. Statistics are from commercial trial.															Trial # = 188313		
++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.																	

Table 21. 2018 Performance of Varieties - Conventional Official Trials

5 sites - All Characters

Unadjusted Description @	Code	Rec/T lbs.	Rec/T %Mean	Rec/A lbs.	Rec/A %Mean	Loss Mol %	Rev/T $ ++	Rev/T %Mean	Rev/A $ ++	Rev/A %Mean	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter /Ac	Emerg. %
BETA EXP 687	804	345.6	102	11006	93	1.12	53.73	104	1698	95	18.40	32.11	172	1534	393	0	84.4
BETA EXP 698	810	337.3	99	12134	103	1.06	51.36	99	1831	102	17.93	36.33	223	1632	308	0	80.2
BETA EXP 747	813	345.0	102	12377	105	0.93	53.57	103	1907	107	18.18	36.19	186	1433	273	0	81.9
BETA EXP 758	812	337.0	99	11501	98	1.06	51.26	99	1731	97	17.91	34.52	221	1624	304	10	84.1
BETA EXP 872	803	341.8	101	12279	104	1.08	52.63	101	1874	105	18.18	36.30	212	1696	311	0	71.2
Crystal 620	811	342.1	101	12221	104	1.05	52.73	102	1867	104	18.16	36.10	187	1583	323	0	78.7
Crystal 840	807	338.4	100	12429	105	1.04	51.66	100	1882	105	17.96	37.07	208	1632	299	0	77.4
Crystal R761	817	327.1	96	12172	103	1.17	48.44	93	1789	100	17.53	37.50	237	1771	354	0	82.6
Hilleshög HIL2243Rz	809	342.5	101	10801	92	1.14	52.83	102	1654	93	18.27	31.83	193	1687	366	10	81.7
Hilleshög HM3035Rz	808	348.5	103	9405	80	0.97	54.57	105	1464	82	18.38	27.20	163	1578	270	0	69.9
Hilleshög 9891Rz	805	343.1	101	10198	86	1.03	53.03	102	1563	87	18.18	29.99	172	1561	321	10	84.4
Maribo MA615Rz	802	323.8	95	11277	96	1.23	47.49	92	1640	92	17.43	35.11	277	1721	398	0	79.8
Seedex 8869 Cnv	820	332.7	98	12448	106	0.97	50.05	96	1859	104	17.60	37.71	185	1581	261	10	84.5
Seedex Deuce	815	337.8	100	12417	105	1.02	51.50	99	1885	105	17.90	36.93	185	1648	282	10	82.8
Strube 12720	818	327.6	97	13281	113	1.00	48.57	94	1953	109	17.38	40.90	216	1669	257	10	82.7
Strube 12845	801	330.2	97	12578	107	1.02	49.33	95	1862	104	17.53	38.44	178	1695	275	0	84.5
Strube 12884	806	329.3	97	12793	108	1.04	49.07	95	1885	105	17.50	39.31	233	1645	287	0	78.7
Strube 13897	819	329.7	97	12449	106	0.99	49.17	95	1845	103	17.48	38.03	210	1473	299	20	78.1
SV 48611	816	350.8	103	11930	101	0.99	55.21	106	1868	104	18.52	34.22	143	1597	292	0	80.9
SV 48777	814	351.1	104	11565	98	0.92	55.32	107	1815	102	18.47	33.09	155	1542	244	0	83.4
BTS 80RR52(Check)	821	342.6	101	11120	94	1.11	52.86	102	1704	95	18.24	32.70	174	1656	355	0	85.5
Crystal 101RR (Check)	822	334.8	99	12038	102	1.11	50.64	98	1808	101	17.85	36.23	217	1740	313	0	83.7
Crystal 355RR(Check)	823	349.9	103	11137	94	1.08	54.98	106	1739	97	18.57	32.06	167	1650	336	0	86.6
BTS 8572 (Check)	824	350.3	103	11480	97	1.01	55.09	106	1795	100	18.53	32.99	144	1539	324	0	80.6
Benchmark Mean		344.4		11443.8		1.1	53.4		1761.5		18.3	33.5	175.3	1646.3	331.8		84.1
Trial Mean		339.1		11793		1.05	51.88		1788		18.00	35.12	194	1620	310		81.2
Coeff. of Var. (%)		2.9		6.5		9.1	5.4		7.7		2.5	6.2	23.3	6.7	17.8		7.3
Mean LSD (0.05)		7.4		606		0.08	2.12		104		0.34	1.93	37	96	44		4.2
Mean LSD (0.01)		9.8		803		0.11	2.81		138		0.45	2.55	49	128	59		5.5
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from 5 sites — Created 10/30/2018

%Mean = percentage of trial mean. — Trial # = 18ACSCnv

@ Some varieties not approved for sale. Refer to approval list for approval status.

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 22. 2018 Performance of Varieties - Conventional Official Trials

Casselton ND - All Characters

Unadjusted		Rec/T	Rec/T	Rec/A	Rec/A	Loss	Rev/T	Rev/T	Rev/A	Rev/A	Sugar	Yield	Na	K	AmN	Bolter	Emerg.
Description @	Code	lbs.	%Mean	lbs.	%Mean	Mol %	$ ++	%Mean	$ ++	%Mean	%	T/A	ppm	ppm	ppm	/Ac	%
BETA EXP 687	804	348.1	104	12514	101	0.92	54.44	108	1944	104	18.32	36.25	83	1285	342	0	86.5
BETA EXP 698	810	327.3	98	12777	103	1.04	48.49	96	1888	101	17.40	38.85	141	1810	267	0	79.7
BETA EXP 747	813	345.1	103	12487	101	0.91	53.59	106	1935	104	18.16	36.32	120	1550	240	0	79.7
BETA EXP 758	812	328.8	98	11314	91	1.09	48.91	97	1673	90	17.53	34.86	134	1895	304	0	83.3
BETA EXP 872	803	334.1	100	13283	107	1.12	50.43	100	1993	107	17.83	39.98	144	1851	326	0	76.0
Crystal 620	811	338.9	101	13784	111	0.99	51.82	102	2103	113	17.93	40.77	113	1747	263	0	84.9
Crystal 840	807	335.2	100	12772	103	1.01	50.75	100	1947	104	17.77	37.91	133	1784	259	0	80.2
Crystal R761	817	317.3	95	13107	106	1.26	45.63	90	1881	101	17.13	41.34	165	2039	381	0	87.5
Hilleshög HIL2243Rz	809	322.4	96	11449	92	1.22	47.08	93	1681	90	17.34	35.19	162	1906	382	0	92.2
Hilleshög HM3035Rz	808	353.3	106	10328	83	0.94	55.93	111	1660	89	18.61	28.88	103	1743	236	0	72.4
Hilleshög 9891Rz	805	345.0	103	11192	90	0.98	53.56	106	1730	93	18.22	32.61	106	1601	286	0	90.6
Maribo MA615Rz	802	317.6	95	11737	95	1.28	45.71	90	1681	90	17.15	37.45	181	1967	405	0	91.2
Seedex 8869 Cnv	820	323.8	97	12754	103	0.98	47.47	94	1873	100	17.17	39.35	123	1770	248	0	83.3
Seedex Deuce	815	341.3	102	12687	102	1.13	52.51	104	1959	105	18.20	37.20	128	1955	317	0	87.0
Strube 12720	818	315.8	94	13417	108	1.08	45.19	89	1926	103	16.87	42.38	137	1864	293	0	87.5
Strube 12845	801	318.1	95	12906	104	1.07	45.84	91	1868	100	16.98	40.18	120	1874	286	0	90.1
Strube 12884	806	318.4	95	13622	110	1.08	45.94	91	1951	104	17.00	42.87	160	1832	285	0	78.7
Strube 13897	819	326.8	98	13486	109	0.92	48.35	96	1980	106	17.26	41.62	131	1632	241	0	88.5
SV 48611	816	346.5	104	11600	94	1.05	53.98	107	1828	98	18.37	33.18	113	1818	289	0	81.8
SV 48777	814	354.1	106	12093	98	0.97	56.16	111	1924	103	18.68	33.81	105	1741	245	0	89.1
BTS 80RR52(Check)	821	338.6	101	10973	89	1.08	51.72	102	1676	90	18.01	32.28	114	1811	307	0	87.0
Crystal 101RR (Check)	822	334.7	100	12883	104	1.10	50.62	100	1940	104	17.83	38.59	144	1992	269	0	88.5
Crystal 355RR(Check)	823	353.1	105	11775	95	1.04	55.88	110	1856	99	18.70	33.42	110	1826	287	0	90.6
BTS 8572 (Check)	824	347.8	104	12456	101	0.98	54.35	107	1953	104	18.36	35.81	115	1676	278	0	81.3
Benchmark Mean		343.6		12022		1.05	53.14		1856		18.23	35.03	121	1826	285		86.8
Trial Mean		334.7		12391		1.05	50.60		1869		17.78	37.13	129	1790	293		84.9
Coeff. of Var. (%)		3.2		5.6		9.4	6.0		6.9		2.9	5.8	15.3	12.5	12.3		6.8
Mean LSD (0.05)		17.5		1276		0.16	5.01		232		0.86	3.95	32	367	63		9.5
Mean LSD (0.01)		23.3		1709		0.22	6.69		310		1.15	5.29	43	490	84		12.7
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Casselton ND — Created 10/30/2018

%Mean = percentage of trial mean. — Trial # = 188201

@ Some varieties not approved for sale. Refer to approval list for approval status.

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 23. 2018 Performance of Varieties - Conventional Official Trials
Ada MN - All Characters

Unadjusted		Rec/T	Rec/T	Rec/A	Rec/A	Loss	Rev/T	Rev/T	Rev/A	Rev/A	Sugar	Yield	Na	K	AmN	Bolter	Emerg.
Description @	Code	lbs.	%Mean	lbs.	%Mean	Mol %	$ ++	%Mean	$ ++	%Mean	%	T/A	ppm	ppm	ppm	/Ac	%
BETA EXP 687	804	340.2	101	12502	91	0.86	52.18	103	1907	92	17.86	36.95	153	1396	244	0	92.4
BETA EXP 698	810	328.4	98	13926	102	0.86	48.79	96	2074	100	17.29	42.33	220	1448	201	0	88.9
BETA EXP 747	813	334.8	100	14738	108	0.75	50.63	100	2231	108	17.48	43.89	181	1238	183	0	95.6
BETA EXP 758	812	333.2	99	12429	91	0.79	50.17	99	1869	90	17.45	37.37	167	1389	185	60	94.9
BETA EXP 872	803	336.2	100	14381	105	0.83	51.04	101	2179	105	17.64	42.93	174	1482	185	0	76.4
Crystal 620	811	340.7	102	14324	105	0.78	52.33	103	2206	107	17.82	41.82	134	1365	191	0	92.9
Crystal 840	807	334.2	100	14755	108	0.82	50.45	99	2222	107	17.51	44.27	163	1443	194	0	91.4
Crystal R761	817	331.5	99	14047	103	0.85	49.69	98	2109	102	17.43	42.28	202	1476	192	0	92.6
Hilleshög HIL2243Rz	809	341.7	102	12339	90	0.87	52.61	104	1898	92	17.95	36.11	142	1496	224	60	91.4
Hilleshög HM3035Rz	808	345.4	103	10614	78	0.79	53.67	106	1656	80	18.08	30.71	160	1325	201	0	73.5
Hilleshög 9891Rz	805	340.4	102	11453	84	0.77	52.24	103	1754	85	17.77	33.70	150	1307	194	0	93.1
Maribo MA615Rz	802	329.4	98	13664	100	0.83	49.08	97	2031	98	17.29	41.64	194	1403	196	0	87.9
Seedex 8869 Cnv	820	328.7	98	14955	109	0.68	48.89	96	2219	107	17.10	45.59	152	1229	143	0	94.6
Seedex Deuce	815	335.3	100	14299	104	0.71	50.78	100	2167	105	17.48	42.63	139	1284	162	0	93.4
Strube 12720	818	321.8	96	15644	114	0.69	46.90	92	2278	110	16.78	48.72	165	1292	132	60	92.2
Strube 12845	801	319.8	95	14953	109	0.81	46.35	91	2172	105	16.80	46.57	174	1480	173	0	92.6
Strube 12884	806	313.2	93	14482	106	0.78	44.45	88	2059	99	16.47	46.18	189	1337	185	0	91.1
Strube 13897	819	330.3	99	14085	103	0.68	49.34	97	2108	102	17.20	42.53	141	1203	155	0	90.4
SV 48611	816	346.1	103	14283	104	0.74	53.88	106	2222	107	18.05	41.34	126	1305	183	0	92.0
SV 48777	814	341.4	102	12794	93	0.64	52.53	103	1978	96	17.74	37.34	116	1199	139	0	89.5
BTS 80RR52(Check)	821	344.2	103	13659	100	0.83	53.34	105	2111	102	18.03	39.80	135	1416	217	0	93.8
Crystal 101RR (Check)	822	339.0	101	14172	104	0.79	51.84	102	2169	105	17.74	41.76	160	1444	172	0	92.2
Crystal 355RR(Check)	823	345.9	103	12960	95	0.84	53.83	106	2015	97	18.13	37.45	144	1428	216	0	99.2
BTS 8572 (Check)	824	345.0	103	13129	96	0.78	53.56	105	2039	99	18.03	38.04	134	1326	205	0	92.5
Benchmark Mean		343.5		13480		0.81	53.14		2084		17.98	39.26	143	1404	202		94.4
Trial Mean		335.3		13691		0.78	50.77		2070		17.55	40.92	159	1363	186		91.0
Coeff. of Var. (%)		2.7		6.6		6.4	5.1		7.8		2.5	6.2	29.5	5.2	11.4		4.7
Mean LSD (0.05)		13.3		1327		0.07	3.80		238		0.64	3.71	66	101	30		6.4
Mean LSD (0.01)		17.6		1763		0.09	5.05		317		0.85	4.92	88	134	40		8.5
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Ada MN — Created 10/30/2018

%Mean = percentage of trial mean. — Trial # = 188204

@ Some varieties not approved for sale. Refer to approval list for approval status.

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 24. 2018 Performance of Varieties - Conventional Official Trials
Grand Forks ND - All Characters

Unadjusted Description @	Code	Rec/T lbs.	Rec/T %Mean	Rec/A lbs.	Rec/A %Mean	Loss Mol %	Rev/T $ ++	Rev/T %Mean	Rev/A $ ++	Rev/A %Mean	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter /Ac	Emerg. %
BETA EXP 687	804	330.2	104	11531	98	1.31	49.33	108	1726	103	17.81	35.12	266	1733	457	0	68.8
BETA EXP 698	810	316.5	100	12471	106	1.29	45.40	100	1783	106	17.12	39.51	347	1819	390	0	65.3
BETA EXP 747	813	334.2	105	12510	107	1.08	50.46	111	1884	112	17.79	37.47	291	1582	312	0	60.0
BETA EXP 758	812	308.1	97	12283	105	1.32	43.00	95	1721	103	16.73	39.59	456	1769	383	0	66.6
BETA EXP 872	803	319.8	101	11618	99	1.35	46.35	102	1680	100	17.36	36.00	346	1917	413	0	54.4
Crystal 620	811	316.7	100	11736	100	1.33	45.46	100	1673	100	17.17	37.20	342	1774	436	0	49.8
Crystal 840	807	317.0	100	12383	106	1.32	45.54	100	1770	105	17.16	39.28	372	1845	394	0	55.9
Crystal R761	817	303.7	96	11801	101	1.44	41.72	92	1618	96	16.63	38.93	416	1961	445	0	63.2
Hilleshög HIL2243Rz	809	316.2	100	11021	94	1.33	45.29	100	1586	95	17.15	34.52	302	1803	439	0	57.0
Hilleshög HM3035Rz	808	322.2	102	9131	78	1.13	47.03	103	1315	78	17.24	28.53	259	1705	324	0	54.8
Hilleshög 9891Rz	805	322.2	102	10528	90	1.24	47.02	103	1538	92	17.33	32.94	282	1734	399	0	65.7
Maribo MA615Rz	802	293.5	93	10657	91	1.53	38.80	85	1408	84	16.21	36.14	495	1935	490	0	57.4
Seedex 8869 Cnv	820	314.2	99	12179	104	1.27	44.74	98	1738	104	16.98	38.90	334	1824	381	60	70.9
Seedex Deuce	815	317.5	100	12281	105	1.22	45.67	100	1766	105	17.09	38.83	299	1804	347	60	62.9
Strube 12720	818	298.5	94	12281	105	1.25	40.25	89	1668	99	16.18	40.76	400	1866	329	0	69.0
Strube 12845	801	314.3	99	12782	109	1.21	44.76	98	1820	108	16.93	40.54	316	1904	321	0	68.6
Strube 12884	806	308.7	97	11758	100	1.32	43.15	95	1645	98	16.74	38.42	406	1810	391	0	55.7
Strube 13897	819	303.1	96	12086	103	1.27	41.55	91	1662	99	16.43	39.68	402	1689	391	0	54.3
SV 48611	816	334.0	105	11664	100	1.11	50.42	111	1746	104	17.80	35.45	226	1753	316	0	59.5
SV 48777	814	332.6	105	11911	102	1.12	50.00	110	1794	107	17.75	35.94	263	1678	330	0	66.4
BTS 80RR52(Check)	821	317.4	100	11620	99	1.38	45.64	100	1676	100	17.26	36.43	313	1881	459	0	70.0
Crystal 101RR (Check)	822	303.5	96	11601	99	1.41	41.66	92	1580	94	16.58	38.47	406	1964	425	0	61.7
Crystal 355RR(Check)	823	327.9	104	11644	99	1.27	48.66	107	1714	102	17.65	35.99	246	1779	419	0	64.8
BTS 8572 (Check)	824	330.4	104	11732	100	1.22	49.37	109	1753	104	17.74	35.38	207	1774	397	0	59.2
Benchmark Mean		319.8		11649		1.32	46.33		1681		17.31	36.57	293	1850	425		63.9
Trial Mean		316.8		11717		1.28	45.47		1678		17.12	37.08	333	1804	391		61.7
Coeff. of Var. (%)		3.6		6.9		7.9	7.1		9.2		3.0	5.9	19.4	4.0	14.7		10.7
Mean LSD (0.05)		17.8		1225		0.16	5.10		240		0.80	3.26	103	107	91		9.9
Mean LSD (0.01)		23.7		1628		0.21	6.79		320		1.07	4.34	137	143	122		13.1
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Grand Forks ND — Created 10/03/2018

%Mean = percentage of trial mean. — Trial # = 188207

@ Some varieties not approved for sale. Refer to approval list for approval status.

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 25. 2018 Performance of Varieties - Conventional Official Trials

Scandia MN - All Characters

Unadjusted		Rec/T	Rec/T	Rec/A	Rec/A	Loss	Rev/T	Rev/T	Rev/A	Rev/A	Sugar	Yield	Na	K	AmN	Bolter	Emerg.
Description @	Code	lbs.	%Mean	lbs.	%Mean	Mol %	$ ++	%Mean	$ ++	%Mean	%	T/A	ppm	ppm	ppm	/Ac	%
BETA EXP 687	804	340.5	101	10545	86	1.03	52.26	102	1621	87	18.06	30.88	175	1604	312	0	92.7
BETA EXP 698	810	335.9	100	12051	98	1.01	50.96	100	1825	98	17.81	36.05	212	1584	284	0	89.0
BETA EXP 747	813	332.0	99	12966	106	0.84	49.83	98	1951	105	17.44	38.88	171	1360	233	0	90.9
BETA EXP 758	812	336.6	100	12138	99	0.94	51.14	100	1838	99	17.77	36.18	170	1550	258	0	93.3
BETA EXP 872	803	337.6	100	13384	109	0.98	51.44	101	2037	110	17.86	39.76	198	1634	252	0	77.4
Crystal 620	811	336.7	100	12740	104	0.89	51.19	100	1928	104	17.73	38.06	170	1514	233	0	91.8
Crystal 840	807	335.1	100	13123	107	0.90	50.73	99	1988	107	17.66	39.15	173	1532	228	0	86.7
Crystal R761	817	323.9	96	12578	103	1.05	47.51	93	1842	99	17.24	38.97	212	1651	298	0	92.2
Hilleshög HIL2243Rz	809	346.0	103	10651	87	0.98	53.84	105	1665	90	18.28	30.68	152	1569	285	0	92.2
Hilleshög HM3035Rz	808	335.9	100	10382	85	0.97	50.95	100	1578	85	17.76	30.92	161	1562	277	0	77.1
Hilleshög 9891Rz	805	338.6	101	10576	86	0.95	51.74	101	1616	87	17.88	31.24	142	1532	280	60	89.5
Maribo MA615Rz	802	325.9	97	12057	98	1.05	48.10	94	1777	96	17.34	37.00	225	1588	308	0	89.9
Seedex 8869 Cnv	820	333.2	99	13310	109	0.79	50.16	98	2002	108	17.45	39.96	148	1416	186	0	91.6
Seedex Deuce	815	334.5	99	13014	106	0.89	50.56	99	1959	105	17.62	39.06	157	1523	226	0	90.0
Strube 12720	818	324.7	97	14169	116	0.89	47.73	93	2090	112	17.12	43.55	215	1546	194	0	89.6
Strube 12845	801	326.5	97	12583	103	0.90	48.27	94	1860	100	17.22	38.48	169	1504	233	0	90.9
Strube 12884	806	328.3	98	13683	112	0.94	48.79	95	2036	110	17.36	41.53	214	1504	254	0	93.7
Strube 13897	819	330.4	98	12963	106	0.88	49.38	97	1929	104	17.40	39.43	179	1363	253	0	88.3
SV 48611	816	348.8	104	12753	104	0.87	54.66	107	2005	108	18.31	36.36	131	1516	221	0	93.4
SV 48777	814	349.9	104	11944	97	0.82	54.96	108	1878	101	18.31	34.13	168	1425	197	0	92.9
BTS 80RR52(Check)	821	342.0	102	11022	90	0.91	52.70	103	1695	91	18.01	32.27	131	1555	238	0	93.3
Crystal 101RR (Check)	822	329.9	98	12335	101	1.03	49.24	96	1842	99	17.52	37.38	177	1686	279	0	92.6
Crystal 355RR(Check)	823	347.7	103	11046	90	0.96	54.32	106	1727	93	18.34	31.77	140	1553	282	0	95.4
BTS 8572 (Check)	824	352.1	105	12160	99	0.88	55.59	109	1907	103	18.49	34.70	126	1446	255	0	90.6
Benchmark Mean		342.9		11641		0.95	52.96		1793		18.09	34.03	143	1560	263		93.0
Trial Mean		336.4		12257		0.93	51.09		1858		17.75	36.52	171	1530	253		90.2
Coeff. of Var. (%)		2.2		5.4		6.8	4.2		5.8		2.0	5.7	20.6	3.9	13.4		4.9
Mean LSD (0.05)		11.0		1025		0.09	3.14		167		0.52	3.25	52	85	51		6.3
Mean LSD (0.01)		14.6		1364		0.12	4.17		222		0.69	4.32	69	112	68		8.4
Sig Lvl		**		**		**	**		**		**	**	**	**	**		**

* 2018 Data from Scandia MN — Created 10/29/2018

%Mean = percentage of trial mean. — Trial # = 188208

@ Some varieties not approved for sale. Refer to approval list for approval status.

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 26. 2018 Performance of Varieties - Conventional Official Trials
St Thomas ND - All Characters

Unadjusted Description @	Code	Rec/T lbs.	Rec/T %Mean	Rec/A lbs.	Rec/A %Mean	Loss Mol %	Rev/T $ ++	Rev/T %Mean	Rev/A $ ++	Rev/A %Mean	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Bolter /Ac	Emerg. %
BETA EXP 687	804	378.0	101	8448	95	1.39	63.01	103	1401	95	20.30	22.48	166	1613	590	0	81.6
BETA EXP 698	810	375.0	101	9371	105	1.12	62.17	101	1554	106	19.89	24.99	194	1503	401	0	78.5
BETA EXP 747	813	379.8	102	8960	100	1.08	63.54	103	1503	102	20.07	23.52	172	1412	396	0	82.2
BETA EXP 758	812	380.3	102	9368	105	1.13	63.68	104	1558	106	20.17	24.87	164	1569	401	0	82.4
BETA EXP 872	803	379.4	102	9023	101	1.16	63.41	103	1509	103	20.15	23.77	198	1621	391	0	70.7
Crystal 620	811	378.3	102	8428	95	1.21	63.10	103	1407	96	20.14	22.31	171	1513	472	0	75.5
Crystal 840	807	370.4	99	9020	101	1.18	60.83	99	1487	101	19.68	24.21	221	1538	428	0	72.3
Crystal R761	817	359.1	96	9177	103	1.26	57.59	94	1474	100	19.19	25.49	187	1715	455	0	77.3
Hilleshög HIL2243Rz	809	378.9	102	8589	96	1.34	63.26	103	1436	98	20.27	22.64	196	1702	511	0	76.6
Hilleshög HM3035Rz	808	381.7	102	6578	74	0.98	64.07	104	1115	76	20.07	17.01	140	1539	302	0	71.2
Hilleshög 9891Rz	805	374.9	101	7451	84	1.21	62.13	101	1225	83	19.99	20.08	176	1600	452	0	83.5
Maribo MA615Rz	802	354.9	95	8298	93	1.49	56.38	92	1315	90	19.24	23.49	289	1744	587	0	75.0
Seedex 8869 Cnv	820	365.4	98	9174	103	1.11	59.41	97	1492	102	19.36	25.10	163	1675	355	0	80.5
Seedex Deuce	815	363.6	98	9607	108	1.11	58.89	96	1562	106	19.26	26.21	176	1699	348	0	80.4
Strube 12720	818	373.6	100	10662	120	1.16	61.76	100	1759	120	19.84	28.62	179	1791	358	0	75.7
Strube 12845	801	367.2	99	9500	107	1.14	59.91	97	1544	105	19.51	26.03	129	1690	385	0	80.9
Strube 12884	806	375.9	101	10441	117	1.09	62.40	102	1727	118	19.89	27.89	193	1734	316	0	73.8
Strube 13897	819	359.7	97	9626	108	1.17	57.76	94	1546	105	19.13	26.77	208	1458	440	120	70.3
SV 48611	816	376.7	101	9388	105	1.21	62.63	102	1560	106	20.01	24.90	131	1605	466	0	77.0
SV 48777	814	374.5	101	8804	99	1.06	62.01	101	1455	99	19.80	23.61	140	1688	325	0	79.7
BTS 80RR52(Check)	821	372.4	100	8393	94	1.32	61.40	100	1380	94	19.96	22.62	171	1616	533	0	82.8
Crystal 101RR (Check)	822	367.1	99	9213	103	1.19	59.88	97	1502	102	19.55	25.14	188	1618	420	0	83.4
Crystal 355RR(Check)	823	377.9	101	8185	92	1.23	62.98	102	1373	93	20.13	21.49	176	1650	453	0	83.4
BTS 8572 (Check)	824	377.2	101	8275	93	1.19	62.78	102	1372	93	20.03	21.97	140	1476	474	0	78.9
Benchmark Mean		373.7		8517		1.23	61.76		1407		19.92	22.81	169	1590	470		82.1
Trial Mean		372.6		8916		1.19	61.46		1469		19.82	23.97	178	1615	427		78.1
Coeff. of Var. (%)		2.7		7.1		11.1	4.8		8.2		2.4	6.5	17.4	4.2	21.0		9.6
Mean LSD (0.05)		15.7		1012		0.21	4.51		191		0.71	2.51	47	106	140		10.8
Mean LSD (0.01)		20.9		1348		0.27	5.99		254		0.95	3.34	63	141	187		14.3
Sig Lvl		**		**		**	*		**		*	**	**	**	**		**

* 2018 Data from St Thomas ND — Created 10/11/2018

%Mean = percentage of trial mean. — Trial # = 188211

@ Some varieties not approved for sale. Refer to approval list for approval status.

++ Revenue estimates are based on a $46.40 beet payment at 17.5% sugar & 1.5% loss to molasses and does not consider hauling costs.

Table 27

Calculation for Approval of Sugarbeet Varieties for ACSC Market for 2019

Description	Approval Status	Rec/Ton 2016	Rec/Ton 2017	Rec/Ton 2018	Rec/Ton 2 Yr	Rec/Ton % Bench	Rev/Acre 2016	Rev/Acre 2017	Rev/Acre 2018	Rev/Acre 2 Yr	Rev/Acre % Bench	R/T + $/A Bench	Cercospora Rating + 2016	Cercospora Rating + 2017	Cercospora Rating + 2018	Cercospora Rating + 2 Yr Mean	Cercospora Rating + 3 Yr Mean
Previously Approved (3 Yr)																	**<=5.40**
BTS 80RR52	Approved		334.2	346.5	340.4	100.0		1699	1536	1618	99.1	199.1	4.28	4.37	4.38	4.38	4.34
BTS 8337	Approved		349.5	356.8	353.2	103.8		1842	1619	1731	106.0	209.7	4.62	4.36	4.64	4.50	4.54
BTS 8500	Approved		335.7	343.7	339.7	99.8		1862	1719	1791	109.6	209.5	4.54	4.29	4.40	4.34	4.41
BTS 8524	Approved		330.0	333.6	331.8	97.5		1796	1658	1727	105.8	203.3	4.74	4.38	4.50	4.44	4.54
BTS 8606	Approved		340.5	349.8	345.2	101.4		1882	1684	1783	109.2	210.6	5.12	4.73	4.80	4.76	4.88
BTS 8629	Approved		332.8	343.2	338.0	99.3		1884	1752	1818	111.3	210.6	4.59	4.29	4.52	4.40	4.46
Crystal 093RR	Approved		350.3	356.0	353.2	103.8		1866	1666	1766	108.1	211.9	4.95	4.49	4.88	4.68	4.77
Crystal 247RR	Approved		335.2	345.4	340.3	100.0		1832	1669	1751	107.2	207.2	4.65	4.55	4.54	4.55	4.58
Crystal 355RR	Approved		340.0	350.1	345.1	101.4		1711	1524	1618	99.1	200.4	4.60	4.36	4.52	4.44	4.50
Crystal 467RR	Approved		330.1	340.9	335.5	98.6		1804	1653	1729	105.8	204.4	4.69	4.46	4.61	4.53	4.58
Crystal 572RR	Approved		354.7	354.6	354.7	104.2		1891	1718	1805	110.5	214.7	4.57	4.27	4.45	4.36	4.43
Crystal 573RR	Approved		343.9	354.3	349.1	102.6		1785	1711	1748	107.0	209.6	4.35	4.15	4.38	4.26	4.29
Crystal 574RR	Approved		334.4	342.5	338.5	99.4		1875	1733	1804	110.5	209.9	4.51	4.35	4.42	4.38	4.43
Crystal 578RR	Approved		338.4	346.5	342.5	100.6		1899	1645	1772	108.5	209.1	4.87	4.91	4.74	4.83	4.84
Crystal 684RR	Approved		333.7	342.3	338.0	99.3		1899	1756	1828	111.9	211.2	4.57	4.34	4.41	4.38	4.44
Hilleshög HM4302RR	Approved		334.0	343.8	338.9	99.6		1597	1572	1585	97.0	196.6	4.13	3.93	4.26	4.09	4.10
Hilleshög HM4448RR	Approved		338.0	346.8	342.4	100.6		1829	1720	1775	108.7	209.3	5.21	5.28	5.26	5.27	5.25
Hilleshög HM9528RR	Approved		339.3	344.5	341.9	100.5		1785	1632	1709	104.6	205.1	4.73	4.99	4.79	4.89	4.84
Hilleshög HIL9708	Approved		338.6	346.9	342.8	100.7		1640	1684	1662	101.8	202.5	4.74	4.61	4.71	4.66	4.69
Maribo MA109	Approved		347.6	354.3	351.0	103.1		1569	1522	1546	94.6	197.8	4.14	4.14	4.33	4.23	4.20
Maribo MA305	Approved		331.7	337.3	334.5	98.3		1731	1589	1660	101.7	199.9	4.72	4.98	4.92	4.95	4.87
Maribo MA502	Approved		329.8	335.4	332.6	97.7		1642	1520	1581	96.8	194.5	4.79	5.01	4.95	4.98	4.92
Maribo MA504	Approved		333.9	343.0	338.5	99.4		1830	1748	1789	109.6	209.0	5.04	5.50	4.98	5.24	5.17
SV RR265	Approved		336.8	343.7	340.3	100.0		1836	1663	1750	107.1	207.1	5.00	5.19	4.48	4.83	4.89
SV RR266	Approved		337.9	345.5	341.7	100.4		1814	1644	1729	105.9	206.3	4.74	4.61	4.73	4.67	4.69
SV RR268	Approved		341.1	350.3	345.7	101.6		1802	1679	1741	106.6	208.2	5.13	5.06	4.70	4.88	4.97
SV RR333	Approved		338.9	351.1	345.0	101.4		1823	1642	1733	106.1	207.5	4.85	4.84	4.78	4.81	4.82
SV RR351	Approved		337.3	347.4	342.4	100.6		1783	1661	1722	105.5	206.0	4.50	4.41	4.61	4.51	4.51
SX Avalanche RR	Approved		342.2	348.8	345.5	101.5		1690	1582	1636	100.2	201.7	4.74	4.64	4.50	4.57	4.63
SX Bronco RR(1863)	Approved		342.4	349.0	345.7	101.6		1773	1647	1710	104.7	206.3	4.35	4.08	4.65	4.37	4.36
SX Canyon RR	Approved		342.4	346.0	344.2	101.1		1829	1674	1752	107.3	208.4	4.76	4.92	4.79	4.85	4.82
SX Cruze RR	Approved		318.4	319.5	319.0	93.7		1696	1465	1581	96.8	190.5	4.65	5.37	5.79	5.58	5.27
SX Marathon RR	Approved		340.4	347.2	343.8	101.0		1812	1717	1765	108.1	209.1	4.44	4.54	5.27	4.90	4.75
Candidates for Approval (2 Yr)																**<=5.00**	
BTS 8735	Approved		335.7	354.1	344.9	101.3		1836	1689	1763	107.9	209.3	--	4.22	4.21	4.22	--
BTS 8749	Approved		337.7	347.6	342.7	100.7		1719	1596	1658	101.5	202.2	--	4.05	4.10	4.08	--
BTS 8767	Approved		339.2	344.7	342.0	100.5		1878	1664	1771	108.5	208.9	--	4.16	4.32	4.24	--
BTS 8784	Approved		351.4	358.0	354.7	104.2		1787	1667	1727	105.8	210.0	--	3.65	3.73	3.69	--
Crystal 792RR	Approved		344.0	349.9	347.0	101.9		1799	1684	1742	106.6	208.6	--	3.94	4.26	4.10	--
Crystal 793RR	Approved		347.5	356.7	352.1	103.5		1896	1804	1850	113.3	216.7	--	3.93	4.26	4.10	--
Crystal 796RR	Approved		337.0	345.4	341.2	100.3		1950	1743	1847	113.1	213.3	--	4.85	4.74	4.79	--
Hilleshög HIL9920	Approved		347.2	355.2	351.2	103.2		1785	1695	1740	106.6	209.7	--	4.89	4.79	4.84	--
Maribo MA717	Approved		342.0	354.4	348.2	102.3		1742	1666	1704	104.3	206.7	--	4.85	4.78	4.81	--
SV RR371	Approved		339.0	346.0	342.5	100.6		1833	1622	1728	105.8	206.4	--	4.59	4.71	4.65	--
SV RR375	Not Approved		342.4	347.2	344.8	101.3		1802	1648	1725	105.6	206.9	--	5.08	4.96	5.02	--
SX RR1879	Approved		338.5	347.1	342.8	100.7		1770	1652	1711	104.8	205.5	--	4.88	4.44	4.66	--
Benchmark Varieties		2016	2017	2018			2016	2017	2018								
BTS 81RR17(Check)	Benchmark	310.2					1845										
Hilleshög HM4302RR	Benchmark	317.4	334.0				1801	1597									
BTS 80RR52	Benchmark	316.8	334.2	346.5			1960	1699	1536								
Crystal 101RR	Benchmark	306.3	329.3	337.8			1849	1718	1602								
Crystal 355RR	Benchmark		340.0	350.1				1711	1524								
BTS 8572	Benchmark			350.7					1677								
Benchmark mean		312.7	334.4	346.3	340.3		1864	1681	1585	1633							

+ All Cercospora ratings 2016-2018 were adjusted to 1982 basis. Created 11-05-2018

Variety approval criteria include: 1) 2 years of official trial data, 2) Cercospora rating must not exceed 5.00 (1982 adjusted data), 3a) R/T >= 100% of Bench or 3b) R/T >= 97% and R/T + $/A >= 202% of Bench. 3 yrs of data may be considered for initial approval.

Bench for 2018 added Beta 8572 and dropped Hill 4302(Check).

To maintain approval, the 3-year Cercospora rating must not exceed 5.40 (1982 adjusted data).

Table 28

Projected Calculation for Approval of Sugarbeet Varieties for ACSC Market

		Rec/Ton		Rev/Acre		R/T +	CR Rating ^^
	Approval ^		%		%	$/A	
Description	Likely	2018	Bench	2018	Bench	Bench	2018
Candidates for Retesting (1 Yr)							
BTS 8815	On Track	351.1	101.4	1670	105.4	206.8	4.65
BTS 8826	On Track	352.1	101.7	1522	96.0	197.7	4.21
BTS 8839	On Track	354.4	102.3	1627	102.7	205.0	4.41
BTS 8844	On Track	353.9	102.2	1608	101.5	203.7	4.62
BTS 8857	On Track	349.9	101.0	1472	92.9	193.9	4.36
BTS 8864	On Track	356.1	102.8	1605	101.3	204.1	4.32
BTS 8882	On Track	345.3	99.7	1709	107.8	207.6	4.53
BTS 8891	On Track	356.3	102.9	1612	101.7	204.6	4.57
Crystal 802RR	On Track	353.3	102.0	1647	103.9	206.0	4.46
Crystal 803RR	On Track	352.2	101.7	1727	109.0	210.7	4.01
Crystal 804RR	On Track	343.5	99.2	1731	109.2	208.4	4.42
Crystal 807RR	On Track	347.9	100.5	1692	106.8	207.2	4.49
Crystal 808RR	On Track	347.8	100.4	1771	111.8	212.2	4.86
Crystal 809RR	On Track	350.6	101.2	1566	98.8	200.1	4.63
Hilleshög HIL2230	Not On Track	342.7	99.0	1578	99.6	198.5	4.71
Hilleshög HIL2231	Not On Track	334.3	96.5	1398	88.2	184.8	4.85
Hilleshög HIL2232	On Track	349.9	101.0	1547	97.6	198.7	4.37
Hilleshög HIL2233	On Track	351.4	101.5	1705	107.6	209.1	4.87
Hilleshög HIL2234	Not On Track	341.2	98.5	1552	97.9	196.5	4.33
Hilleshög HIL2235	Not On Track	342.9	99.0	1592	100.5	199.5	4.11
Hilleshög HIL2236	On Track	350.9	101.3	1566	98.8	200.2	4.92
Maribo MA808	Not On Track	337.7	97.5	1430	90.2	187.8	4.99
Maribo MA809	Not On Track	334.4	96.6	1596	100.7	197.3	4.55
Maribo MA810	Not On Track	343.8	99.3	1467	92.6	191.9	5.36
Maribo MA811	Not On Track	344.5	99.5	1578	99.6	199.1	4.84
Maribo MA812	On Track	351.6	101.5	1532	96.7	198.2	4.90
SV 284	Not On Track	345.7	99.8	1581	99.8	199.6	4.07
SV 285	On Track	346.3	100.0	1633	103.0	203.1	4.52
SV 286	Not On Track	345.6	99.8	1610	101.6	201.4	5.25
SV 287	Not On Track	341.2	98.5	1615	101.9	200.4	5.28
SV 288	Not On Track	338.9	97.9	1612	101.7	199.6	4.88
SV 289	On Track	351.3	101.5	1689	106.6	208.0	4.65
SX 1885	Not On Track	346.0	99.9	1609	101.5	201.5	5.32
SX 1886	On Track	345.3	99.7	1628	102.7	202.4	4.79
SX 1887	On Track	348.6	100.7	1659	104.7	205.4	4.89
SX 1888	On Track	349.3	100.9	1698	107.1	208.0	4.92
SX 1889	On Track	346.3	100.0	1496	94.4	194.4	3.91
Benchmarks							
BTS 80RR52		346.5	100.1	1536	96.9		
Crystal 101RR		337.8	97.6	1602	101.1		
Crystal 355RR		350.1	101.1	1524	96.2		
BTS 8572		350.7	101.3	1677	105.8		
Benchmark Mean		346.3		1585			

^ Not on Track = not on track for approval. On Track = data is tracking for potential approval. Created 11-05-2018

^^ All Cercospora ratings 2018 were adjusted to 1982 basis.

Full market approval criteria include: 1) 2 years of official trial data, 2) Cercospora rating must not exceed 5.00 (1982 adjusted data),
3a) R/T >= 100% of Bench or 3b) R/T >= 97% and R/T + $/A equal to 202 of Bench.

Bench for 2018 added Beta 8572 and dropped Hill 4302(Check).

Table 29

Calculation for Approval of Sugarbeet Varieties for ACSC Aphanomyces Specialty Market for 2019

Trial Yrs	Description	Approval Status	Root Aph. Rating 2016	2017	2018	2 Yr	3 Yr	Cercospora Rating + 2016	2017	2018	2 Yr	3 Yr
	Previously Approved (3 Yrs)						**<=4.70**					**<=5.40**
9	BTS 80RR52	Approved	4.11	4.36	4.49	4.43	4.32	4.28	4.37	4.38	4.38	4.34
6	BTS 8337	Approved	3.26	3.78	3.74	3.76	3.59	4.62	4.36	4.64	4.50	4.54
4	BTS 8500	Approved	4.22	4.52	4.43	4.48	4.39	4.54	4.29	4.40	4.35	4.41
4	BTS 8524	Approved	3.89	4.49	4.08	4.29	4.15	4.74	4.38	4.50	4.44	4.54
9	Crystal 093RR	Approved	4.32	4.43	4.38	4.41	4.38	4.95	4.49	4.88	4.69	4.77
6	Crystal 355RR	Approved	4.46	4.84	4.42	4.63	4.57	4.60	4.36	4.52	4.44	4.49
5	Crystal 467RR	Approved	4.04	3.96	3.68	3.82	3.89	4.69	4.46	4.61	4.54	4.59
4	Crystal 573RR	Approved	4.06	3.84	4.33	4.09	4.08	4.35	4.15	4.38	4.27	4.29
4	Crystal 574RR	Approved	3.69	4.72	4.32	4.52	4.24	4.51	4.35	4.42	4.39	4.43
3	Crystal 684RR	Approved	3.74	4.31	3.83	4.07	3.96	4.57	4.34	4.41	4.38	4.44
6	Hilleshög HM9528RR	Approved	3.77	5.63	4.22	4.93	4.54	4.73	4.99	4.79	4.89	4.84
5	Maribo MA109	Approved	4.27	5.06	4.38	4.72	4.57	4.14	4.14	4.33	4.24	4.20
4	Maribo MA502	Approved	3.06	3.53	3.67	3.60	3.42	4.79	5.01	4.95	4.98	4.92
3	SV RR268	Approved	4.00	4.71	4.21	4.46	4.31	5.13	5.06	4.70	4.88	4.96
6	SV RR333	Approved	4.71	4.99	4.06	4.53	4.59	4.85	4.84	4.78	4.81	4.82
4	SV RR351	Approved	4.38	4.18	4.50	4.34	4.35	4.50	4.41	4.61	4.51	4.51
4	SX Avalanche RR	Approved	4.44	4.00	4.18	4.09	4.21	4.74	4.64	4.50	4.57	4.63
3	SX Bronco RR(1863)	Approved	3.55	4.88	4.05	4.47	4.16	4.35	4.08	4.65	4.37	4.36
5	SX Cruze RR	Approved	3.41	4.79	4.38	4.59	4.19	4.65	5.37	5.79	5.58	5.27
5	SX Canyon RR	Approved	4.28	4.33	4.34	4.34	4.32	4.76	4.92	4.79	4.86	4.82
	Candidates for Approval					**<=4.40**						**<=5.00**
3	BTS 8606	NO	4.60	4.91	4.43	4.67	4.65	5.12	4.73	4.80	4.77	4.88
3	BTS 8629	Approved	4.14	4.68	3.89	4.29	4.24	4.59	4.29	4.52	4.41	4.47
2	BTS 8735	Approved	--	4.74	4.00	4.37	--	--	4.22	4.21	4.22	--
2	BTS 8749	Approved	--	3.53	2.79	3.16	--	--	4.05	4.10	4.08	--
2	BTS 8767	NO	--	4.80	4.28	4.54	--	--	4.16	4.32	4.24	--
2	BTS 8784	NO	--	4.59	4.22	4.41	--	--	3.65	3.73	3.69	--
7	Crystal 247RR	NO	4.77	5.35	5.02	5.19	5.05	4.65	4.55	4.54	4.55	4.58
4	Crystal 572RR	NO	4.74	4.69	4.47	4.58	4.63	4.57	4.27	4.45	4.36	4.43
4	Crystal 578RR	Approved	4.44	4.56	4.21	4.39	4.40	4.87	4.91	4.74	4.83	4.84
2	Crystal 792RR	Approved	--	4.73	3.78	4.26	--	--	3.94	4.26	4.10	--
2	Crystal 793RR	Approved	--	3.02	3.32	3.17	--	--	3.93	4.26	4.10	--
2	Crystal 796RR	Approved	--	3.11	3.61	3.36	--	--	4.85	4.74	4.80	--
8	Hilleshög HM4302RR	NO	4.63	6.66	4.65	5.66	5.31	4.13	3.93	4.26	4.10	4.11
7	Hilleshög HM4448RR	NO	3.90	6.29	4.53	5.41	4.91	5.21	5.28	5.26	5.27	5.25
4	Hilleshög HIL9708	NO	4.82	5.94	4.25	5.10	5.00	4.74	4.61	4.71	4.66	4.69
2	Hilleshög HIL9920	NO	--	4.94	4.09	4.52	--	--	4.89	4.79	4.84	--
6	Maribo 305	NO	4.42	5.67	4.91	5.29	5.00	4.72	4.98	4.92	4.95	4.87
4	Maribo MA504	NO	4.54	6.20	5.30	5.75	5.35	5.04	5.50	4.98	5.24	5.17
2	Maribo MA717	NO	--	5.31	4.15	4.73	--	--	4.85	4.78	4.82	--
2	SX RR1879	Approved	--	4.18	4.39	4.29	--	--	4.88	4.44	4.66	--
4	SX Marathon RR	NO	4.38	4.52	4.72	4.62	4.54	4.44	4.54	5.27	4.91	4.75
2	SV RR265	NO	--	4.55	4.51	4.53	--	--	4.59	4.71	4.65	--
3	SV RR266	NO	4.62	5.64	4.72	5.18	4.99	4.74	4.61	4.73	4.67	4.69
2	SV RR371	NO	--	4.55	4.51	4.53	--	--	4.59	4.71	4.65	--
2	SV RR375	NO	--	4.54	3.83	4.19	--	--	5.08	4.96	5.02	--
	Approval Criteria new varieties					4.40					5.00	
	Criteria to Maintain Approval						4.70					5.40

+ All Cercospora ratings 2016-2018 were adjusted to 1982 basis. Created 11/6/2018

Aphanomyces approval criteria include: 1) Cercospora rating must not exceed 5.00 (1982 adjusted data), 2) Aph root rating <= 4.40 after 2 years.

3 yrs of data may be considered for initial approval.

To maintain Aphanomyces approval criteria include: 1) Cercospora 3 year mean must not exceed 5.40, 2) Aph root rating <= 4.70 after 3 years.

Table 30

Calculation for Approval of Sugarbeet Varieties for ACSC Rhizoctonia Specialty Market for 2019

Description	Approval Status	Disease Index + 2016	2017	2018	2 Yr Mn	3 Yr Mn	Cercospora Rating 2016	2017	2018	2 Yr Mn	3 Yr Mn
Previously Approved (3 Yr)											
Crystal 355RR	Approved	3.96	4.09	3.66	3.88	3.90	4.60	4.36	4.52	4.44	4.49
Hilleshög HM4302RR	Approved	3.65	3.60	3.71	3.66	3.65	4.13	3.93	4.26	4.10	4.11
Maribo MA109	Approved	3.69	3.63	3.69	3.66	3.67	4.14	4.14	4.33	4.24	4.20
Candidates for Approval (2 Yr)											
BTS 80RR52	Not Approved	4.41	4.14	3.96	4.05	4.17	4.28	4.37	4.38	4.38	4.34
BTS 8337	Not Approved	4.08	4.30	4.07	4.19	4.15	4.62	4.36	4.64	4.50	4.54
BTS 8500	Not Approved	4.43	4.57	4.36	4.47	4.45	4.54	4.29	4.40	4.35	4.41
BTS 8524	Not Approved	4.20	4.41	4.23	4.32	4.28	4.74	4.38	4.50	4.44	4.54
BTS 8606	Not Approved	4.48	5.00	4.24	4.62	4.57	5.12	4.73	4.80	4.77	4.88
BTS 8629	Not Approved	3.73	4.21	4.02	4.12	3.99	4.59	4.29	4.52	4.41	4.47
BTS 8735	Not Approved	--	4.38	4.12	4.25	--	--	4.22	4.21	4.22	--
BTS 8749	Not Approved	--	3.95	3.88	3.92	--	--	4.05	4.10	4.08	--
BTS 8767	Not Approved	--	4.75	4.10	4.43	--	--	4.16	4.32	4.24	--
BTS 8784	Not Approved	--	4.64	4.60	4.62	--	--	3.65	3.73	3.69	--
Crystal 093RR	Not Approved	4.37	4.50	4.59	4.55	4.49	4.95	4.49	4.88	4.69	4.77
Crystal 247RR	Not Approved	4.32	4.49	4.56	4.53	4.46	4.65	4.55	4.54	4.55	4.58
Crystal 467RR	Not Approved	4.26	4.47	3.94	4.21	4.22	4.69	4.46	4.61	4.54	4.59
Crystal 572RR	Not Approved	4.21	4.47	4.54	4.51	4.41	4.57	4.27	4.45	4.36	4.43
Crystal 573RR	Not Approved	4.55	4.57	4.29	4.43	4.47	4.35	4.15	4.38	4.27	4.29
Crystal 574RR	Not Approved	4.47	4.16	4.36	4.26	4.33	4.51	4.35	4.42	4.39	4.43
Crystal 578RR	Not Approved	4.32	4.40	4.30	4.35	4.34	4.87	4.91	4.74	4.83	4.84
Crystal 684RR	Not Approved	4.41	4.57	4.39	4.48	4.46	4.57	4.34	4.41	4.38	4.44
Crystal 792RR	Not Approved	--	3.88	4.22	4.05	--	--	3.94	4.26	4.10	--
Crystal 793RR	Not Approved	--	4.26	4.11	4.19	--	--	3.93	4.26	4.10	--
Crystal 796RR	Not Approved	--	4.23	3.97	4.10	--	--	4.85	4.74	4.80	--
Hilleshög HM4448RR	Not Approved	4.51	4.63	4.38	4.51	4.51	5.21	5.28	5.26	5.27	5.25
Hilleshög HM9528RR	Not Approved	4.21	4.21	4.04	4.13	4.15	4.73	4.99	4.79	4.89	4.84
Hilleshög HIL9708	Not Approved	4.28	4.21	3.71	3.96	4.07	4.74	4.61	4.71	4.66	4.69
Hilleshög HIL9920	Not Approved	--	4.48	4.65	4.57	--	--	4.89	4.79	4.84	--
Maribo MA305	Not Approved	4.40	4.60	4.26	4.43	4.42	4.72	4.98	4.92	4.95	4.87
Maribo MA502	Not Approved	4.73	4.78	4.20	4.49	4.57	4.79	5.01	4.95	4.98	4.92
Maribo MA504	Not Approved	4.58	4.37	4.25	4.31	4.40	5.04	5.50	4.98	5.24	5.17
Maribo MA717	Not Approved	--	4.28	4.35	4.32	--	--	4.85	4.78	4.82	--
SV RR265	Not Approved	4.44	4.42	4.32	4.37	4.39	5.00	5.19	4.48	4.84	4.89
SV RR266	Not Approved	4.20	4.39	4.34	4.37	4.31	4.74	4.61	4.73	4.67	4.69
SV RR268	Not Approved	4.70	4.57	4.21	4.39	4.49	5.13	5.06	4.70	4.88	4.96
SV RR333	Not Approved	4.44	4.44	4.23	4.34	4.37	4.85	4.84	4.78	4.81	4.82
SV RR351	Not Approved	4.17	4.25	4.16	4.21	4.19	4.50	4.41	4.61	4.51	4.51
SV RR371	Not Approved	--	4.31	4.19	4.25	--	--	4.59	4.71	4.65	--
SV RR375	Not Approved	--	4.25	4.13	4.19	--	--	5.08	4.96	5.02	--
SX Avalanche RR	Not Approved	4.52	4.29	4.36	4.33	4.39	4.74	4.64	4.50	4.57	4.63
SX Bronco RR(1863)	Not Approved	4.54	4.23	4.73	4.48	4.50	4.35	4.08	4.65	4.37	4.36
SX Canyon RR	Not Approved	4.40	4.51	4.36	4.44	4.42	4.76	4.92	4.79	4.86	4.82
SX Cruze RR	Not Approved	4.69	4.39	4.23	4.31	4.44	4.65	5.37	5.79	5.58	5.27
SX Marathon RR	Not Approved	4.47	4.40	4.19	4.30	4.35	4.44	4.54	5.27	4.91	4.75
SX RR1879	Not Approved	--	4.36	4.32	4.34	--	--	4.88	4.44	4.66	--
Susceptible Checks											
RH CK#08 CRYS539RR		4.84	4.74	4.68							
RH CK#21 CRYS768RR		4.32	4.66	4.52							
RH CK#25 HILL4043RR		4.76	4.51	4.83							
RH CK#28 CRYS658RR		4.57	4.36	4.02							
RH CK#29 BETA87RR58		4.67	4.79	--							
RH CK#31 HILL4000RR		4.80	4.65	--							
RH CK#35 SES36812RR		4.55	4.71	4.29							
RH CK#36 BTS85RR02		4.45	4.10	4.46							
RH CK#37 SES36918RR		4.67	4.43	4.32							
RH CK#40 CRYS101RR		4.65	4.55	4.50							
RH CK#45 BTS82RR33		4.19	4.73	4.70							
RH CK#47 SES36272RR		4.50	4.62	4.36							
RH CK#49 CRYS247RR		4.38	4.65	4.62							
Susceptible Hybrid Mean		4.64	4.66	4.48	4.57	4.59				**5.00**	**5.40**
Approval Criteria ++		3.82	3.82	3.82	**3.82**	**3.82**					
Disapproval Criteria						**4.13**					

Rhc and CR ratings were adjusted based upon check performance.

Created 11/6/2018

+ Disease Index is based on a scale of 0 (healthy) to 7 (dead).

++ Candidates must have better tolerance than susc. check mean * 80%. To maintain approval, tolerance must be better than susc. check mean * 90%.

Previously approved varieties not meeting current approval standards may be sold in 2018.

		Table 31. 2018 Aphanomyces Ratings for Official Trial Entries Betaseed Nursery - Shakopee, MN & ACSC - RRV										
			Unadjusted ^^		Adjusted ^^							
			George	Shak	George	Shak						Trial
Chk++	Code	Description	7/31	8/22	7/31	8/22	2018	2 Yr	3 Yr	2017^^	2016 ^^	Yrs $$
	570	BTS 80RR52	4.62	4.15	4.58	4.40	4.49	4.43	4.32	4.36	4.11	9
	501	BTS 8337	4.07	3.25	4.03	3.44	3.74	3.76	3.59	3.78	3.26	6
	577	BTS 8500	4.31	4.34	4.27	4.60	4.43	4.48	4.39	4.52	4.22	4
	503	BTS 8524	3.90	4.05	3.87	4.29	4.08	4.28	4.15	4.49	3.89	4
	576	BTS 8606	4.41	4.23	4.37	4.48	4.43	4.67	4.64	4.91	4.60	3
	527	BTS 8629	4.21	3.41	4.17	3.61	3.89	4.28	4.24	4.68	4.14	3
	521	BTS 8735	3.83	3.97	3.80	4.20	4.00	4.37	--	4.74	--	2
	512	BTS 8749	3.04	2.43	3.01	2.57	2.79	3.16	--	3.53	--	2
	568	BTS 8767	4.33	4.02	4.29	4.26	4.28	4.54	--	4.80	--	2
	572	BTS 8784	4.45	3.81	4.41	4.03	4.22	4.40	--	4.59	--	2
	529	BTS 8815	4.09	3.67	4.05	3.89	3.97	--	--	--	--	1
	505	BTS 8826	4.87	5.13	4.83	5.43	5.13	--	--	--	--	1
	536	BTS 8839	3.69	3.60	3.66	3.81	3.74	--	--	--	--	1
	516	BTS 8844	3.55	3.46	3.52	3.66	3.59	--	--	--	--	1
	531	BTS 8857	5.06	4.74	5.02	5.02	5.02	--	--	--	--	1
	554	BTS 8864	4.45	4.78	4.41	5.06	4.74	--	--	--	--	1
	535	BTS 8882	5.06	4.67	5.02	4.95	4.98	--	--	--	--	1
	553	BTS 8891	4.42	3.58	4.38	3.79	4.09	--	--	--	--	1
	530	Crystal 093RR	4.12	4.42	4.08	4.68	4.38	4.41	4.38	4.43	4.32	9
	542	Crystal 247RR	4.72	5.07	4.68	5.37	5.02	5.19	5.05	5.35	4.77	7
	562	Crystal 355RR	4.14	4.48	4.10	4.74	4.42	4.63	4.58	4.84	4.46	6
	513	Crystal 467RR	3.90	3.30	3.87	3.49	3.68	3.82	3.90	3.96	4.04	5
	518	Crystal 572RR	4.26	4.45	4.22	4.71	4.47	4.58	4.63	4.69	4.74	4
	563	Crystal 573RR	4.40	4.06	4.36	4.30	4.33	4.09	4.08	3.84	4.06	4
	575	Crystal 574RR	4.15	4.28	4.11	4.53	4.32	4.52	4.24	4.72	3.69	4
	508	Crystal 578RR	4.20	4.01	4.16	4.25	4.21	4.38	4.40	4.56	4.44	4
	545	Crystal 684RR	3.71	3.76	3.68	3.98	3.83	4.07	3.96	4.31	3.74	3
	522	Crystal 792RR	4.01	3.39	3.98	3.59	3.78	4.26	--	4.73	--	2
	557	Crystal 793RR	3.58	2.92	3.55	3.09	3.32	3.17	--	3.02	--	2
	574	Crystal 796RR	3.87	3.20	3.84	3.39	3.61	3.36	--	3.11	--	2
	519	Crystal 802RR	3.98	3.73	3.95	3.95	3.95	--	--	--	--	1
	558	Crystal 803RR	3.99	3.56	3.96	3.77	3.86	--	--	--	--	1
	517	Crystal 804RR	3.91	3.11	3.88	3.29	3.58	--	--	--	--	1
	550	Crystal 807RR	4.96	4.23	4.92	4.48	4.70	--	--	--	--	1
	547	Crystal 808RR	3.73	3.30	3.70	3.49	3.60	--	--	--	--	1
	534	Crystal 809RR	3.37	3.70	3.34	3.92	3.63	--	--	--	--	1
	580	Hilleshög HM4302RR	4.56	4.52	4.52	4.79	4.65	5.66	5.32	6.66	4.63	8
	510	Hilleshög HM4448RR	4.42	4.42	4.38	4.68	4.53	5.41	4.91	6.29	3.90	7
	543	Hilleshög HM9528RR	3.87	4.35	3.84	4.61	4.22	4.93	4.54	5.63	3.77	6
	560	Hilleshög HIL2230	3.70	4.01	3.67	4.25	3.96	--	--	--	--	1
	581	Hilleshög HIL2231	3.72	3.86	3.69	4.09	3.89	--	--	--	--	1
	502	Hilleshög HIL2232	3.68	4.46	3.65	4.72	4.19	--	--	--	--	1
	566	Hilleshög HIL2233	4.16	3.69	4.12	3.91	4.02	--	--	--	--	1
	579	Hilleshög HIL2234	4.80	4.53	4.76	4.80	4.78	--	--	--	--	1
	514	Hilleshög HIL2235	4.46	4.56	4.42	4.83	4.63	--	--	--	--	1
	506	Hilleshög HIL2236	3.69	4.88	3.66	5.17	4.41	--	--	--	--	1
	533	Hilleshög HIL9708	4.19	4.10	4.15	4.34	4.25	5.09	5.00	5.94	4.82	4
	525	Hilleshög HIL9920	3.80	4.17	3.77	4.42	4.09	4.52	--	4.94	--	2

	541	Maribo MA109	3.80	4.72	3.77	5.00	4.38	4.72	4.57	5.06	4.27	5
	532	Maribo MA305	4.28	5.26	4.24	5.57	4.91	5.29	5.00	5.67	4.42	6
	515	Maribo MA502	3.85	3.32	3.82	3.52	3.67	3.60	3.42	3.53	3.06	4
	504	Maribo MA504	4.88	5.44	4.84	5.76	5.30	5.75	5.34	6.20	4.54	4
	567	Maribo MA717	4.00	4.10	3.97	4.34	4.15	4.73	--	5.31	--	2
	578	Maribo MA808	4.09	4.47	4.05	4.73	4.39	--	--	--	--	1
	509	Maribo MA809	4.95	4.85	4.91	5.14	5.02	--	--	--	--	1
	571	Maribo MA810	4.28	3.59	4.24	3.80	4.02	--	--	--	--	1
	564	Maribo MA811	4.21	4.33	4.17	4.59	4.38	--	--	--	--	1
	556	Maribo MA812	3.71	4.30	3.68	4.55	4.12	--	--	--	--	1
	511	SV 284	4.19	4.54	4.15	4.81	4.48	--	--	--	--	1
	561	SV 285	3.68	4.08	3.65	4.32	3.98	--	--	--	--	1
	526	SV 286	4.59	4.71	4.55	4.99	4.77	--	--	--	--	1
	520	SV 287	4.26	3.94	4.22	4.17	4.20	--	--	--	--	1
	507	SV 288	5.12	5.39	5.08	5.71	5.39	--	--	--	--	1
	523	SV 289	4.17	4.45	4.13	4.71	4.42	--	--	--	--	1
	552	SV RR265	3.87	4.23	3.84	4.48	4.16	4.76	4.69	5.35	4.54	3
	540	SV RR266	4.23	4.95	4.19	5.24	4.72	5.18	4.99	5.64	4.62	3
	548	SV RR268	3.96	4.25	3.93	4.50	4.21	4.46	4.31	4.71	4.00	3
	537	SV RR333	3.86	4.05	3.83	4.29	4.06	4.52	4.59	4.99	4.71	6
	544	SV RR351	4.03	4.72	4.00	5.00	4.50	4.34	4.35	4.18	4.38	4
	582	SV RR371	3.94	4.83	3.91	5.12	4.51	4.53	--	4.55	--	2
	555	SV RR375	3.51	3.95	3.48	4.18	3.83	4.19	--	4.54	--	2
	538	SX 1885	4.02	5.01	3.99	5.31	4.65	--	--	--	--	1
	539	SX 1886	4.28	4.44	4.24	4.70	4.47	--	--	--	--	1
	559	SX 1887	4.28	4.47	4.24	4.73	4.49	--	--	--	--	1
	546	SX 1888	3.93	3.94	3.90	4.17	4.03	--	--	--	--	1
	565	SX 1889	5.07	5.00	5.03	5.30	5.16	--	--	--	--	1
	573	SX Avalanche RR	3.82	4.32	3.79	4.58	4.18	4.09	4.21	4.00	4.44	4
	569	SX Bronco RR(1863)	4.61	3.33	4.57	3.53	4.05	4.46	4.16	4.88	3.55	3
	551	SX Canyon RR	4.08	4.37	4.04	4.63	4.34	4.33	4.32	4.33	4.28	5
	549	SX Cruze RR	4.16	4.38	4.12	4.64	4.38	4.58	4.19	4.79	3.41	5
	528	SX Marathon RR	4.40	4.80	4.36	5.08	4.72	4.62	4.54	4.52	4.38	4
	524	SX RR1879	4.43	4.15	4.39	4.40	4.39	4.28	--	4.18	--	2
1	1001	AP CK#32 CRYS981RR	4.19	3.24	4.15	3.43	3.79	3.49	3.56	3.19	3.71	10
1	1002	AP CK#33 CRYS768RR	4.48	4.42	4.44	4.68	4.56	4.65	4.67	4.74	4.71	12
1	1003	AP CK#34 HILL4000RR	4.99	4.99	4.95	5.28	5.12	5.94	5.79	6.76	5.49	12
1	1004	AP CK#35 BETA87RR58	5.59	5.49	5.54	5.81	5.68	5.27	5.25	4.86	5.20	12
1	1005	AP CK#41 CRYS765RR	5.89	5.80	5.84	6.14	5.99	6.00	5.94	6.01	5.81	8
1	1006	AP CK#43 BTS80RR32	4.65	4.34	4.61	4.60	4.60	4.62	4.63	4.64	4.66	9
1	1007	AP CK#44 SX VISION RR	5.01	4.80	4.97	5.08	5.03	5.10	5.06	5.17	4.97	10
1	1008	AP CK#45 CRYS986RR	4.01	3.81	3.98	4.03	4.01	4.11	4.28	4.22	4.60	10
1	1009	AP CK#47 CRYS101RR	4.24	3.18	4.20	3.37	3.79	3.81	3.68	3.83	3.41	8
1	1010	AP CK#49 BTS82RR33	5.61	4.80	5.56	5.08	5.32	5.80	5.75	6.29	5.63	7
1	1011	AP CK#51 CRYS246RR	5.12	5.06	5.08	5.36	5.22	4.94	4.92	4.65	4.89	7
1	1012	AP CK#52 HILL4094RR	4.43	4.49	4.39	4.76	4.57	4.57	4.68	4.58	4.90	11
1	1013	AP CK#55 CRYS247RR	5.50	4.91	5.45	5.20	5.33	4.66	4.84	4.00	5.19	7
1	1014	AP CK#56 BTS8363	4.93	5.12	4.89	5.42	5.15	4.88	4.89	4.60	4.93	6
1	1015	AP CK#57 CRYS578RR	4.64	4.15	4.60	4.40	4.50	4.53	4.50	4.56	4.44	4
	1016	AP CHK SUS HYB#3	5.68	5.70	5.63	6.04	5.83	5.41	5.51	4.99	5.70	12
	1017	AP CHK MOD RES RR	5.14	4.33	5.10	4.59	4.84	4.75	4.75	4.65	4.76	12
	1018	AP CHK RES RR	3.90	4.82	3.87	5.10	4.49	4.49	4.30	4.49	3.93	13
	1019	AP CHK SUS HYB#3	6.02	5.52	5.97	5.85	5.91	5.45	5.53	4.99	5.70	12
	1020	AP CHK SUS HYB#4	6.12	5.64	6.07	5.97	6.02	6.00	5.94	5.99	5.82	12
	1021	AP CHK MOD RES RR#2	4.49	5.26	4.45	5.57	5.01	4.89	4.84	4.78	4.74	12
	1022	AP CHK MOD RES RR#3	4.64	4.84	4.60	5.13	4.86	5.02	5.02	5.17	5.03	10
	1023	AC CHK RES RR#3	3.95	2.94	3.92	3.11	3.51	3.37	3.26	3.23	3.02	11

		Conventional										
	910	BETA EXP 687	3.94	4.15	3.91	4.39	4.15	4.23	4.44	4.30	4.88	3
	918	BETA EXP 698	4.02	3.20	3.98	3.39	3.68	3.65	3.66	3.62	3.69	3
	919	BETA EXP 747	3.80	4.03	3.77	4.27	4.02	3.81	--	3.60	--	2
	906	BETA EXP 758	4.10	3.16	4.07	3.34	3.70	3.50	--	3.29	--	2
	907	BETA EXP 872	4.27	3.46	4.24	3.66	3.95	--	--	--	--	1
	903	Crystal 620	3.98	3.44	3.95	3.64	3.79	3.94	4.05	4.09	4.28	3
	904	Crystal 840	4.17	3.27	4.13	3.46	3.80	--	--	--	--	1
	917	Crystal R761	4.08	3.91	4.04	4.14	4.09	4.05	3.89	4.01	3.57	12
	912	Hilleshög HIL2243Rz	5.25	4.49	5.20	4.76	4.98	--	--	--	--	1
	911	Hilleshög HM3035Rz	4.63	5.44	4.59	5.76	5.18	5.18	4.92	5.18	4.40	14
	909	Hilleshög 9891Rz	4.06	5.12	4.02	5.42	4.72	4.81	4.69	4.89	4.45	3
	901	Maribo MA615Rz	4.47	4.72	4.43	5.00	4.72	5.01	4.94	5.30	4.80	3
	914	Seedex 8869 Cnv	4.55	4.84	4.52	5.12	4.82	4.90	4.84	4.99	4.70	3
	908	Seedex Deuce	4.51	5.71	4.47	6.05	5.26	5.65	5.67	6.04	5.70	11
	920	Strube 12720	6.36	6.58	6.30	6.97	6.64	7.37	--	8.11	--	2
	905	Strube 12845	5.07	6.99	5.03	7.40	6.22	--	--	--	--	1
	913	Strube 12884	5.25	6.22	5.20	6.58	5.89	--	--	--	--	1
	915	Strube 13897	5.04	5.46	5.00	5.79	5.39	--	--	--	--	1
	902	SV 48611	3.89	5.06	3.85	5.36	4.60	4.43	4.44	4.25	4.47	3
	916	SV 48777	4.21	5.75	4.17	6.09	5.13	4.66	--	4.20	--	2
	1001	AP CK#32 CRYS981RR	4.37	3.35	4.33	3.55	3.94	3.56	3.61	3.19	3.71	10
	1005	AP CK#41 CRYS765RR	6.07	6.16	6.01	6.53	6.27	6.14	6.03	6.01	5.81	8
	1010	AP CK#49 BTS82RR33	5.54	4.97	5.49	5.27	5.38	5.83	5.76	6.29	5.63	7
	1011	AP CK#51 CRYS246RR	4.84	4.41	4.79	4.67	4.73	4.69	4.76	4.65	4.89	7
		Check Mean	4.89	4.57	4.84	4.84	4.84					
15		Trial Mean	4.32	4.29	4.28	4.54	4.41					
		Coeff. of Var. (%)	11.04	12.29	11.04	12.29						
		Mean LSD (0.05)	0.66	0.69	0.65	0.73						
		Mean LSD (0.01)	0.87	0.90	0.86	0.95						
		Sig Lvl	**	**	**	**						
		Adjustment Factor	0.991	1.059								

^^ 2018 Root Rating was taken in early fall (1=healthy, 9+=severe damage).

++ Ratings adjusted to 2003 basis. (2000-2002 Aph nurseries). Ratings adjusted on the basis of checks.

Table 32.

2018 Cercospora Ratings for Official Trial Entries

Betaseed (Randolph MN), BSDF (Frankenmuth MI) & NDSU (Foxhome MN)

			Unadjusted			Adjusted to 1982 Basis ++								
			Randolph	BSDF	Foxhome	Randolph	BSDF	Foxhome						Trial
Chk	Code	Description	Avg	Avg	Avg	Avg	Avg	Avg	2018	2 Yr	3 Yr	2017	2016	Yrs $$
			8 Dates+	5 Dates+	8 Dates+	8 Dates+	5 Dates+	8 Dates+	3 loc					
	570	BTS 80RR52	3.95	4.04	4.38	4.42	4.34	4.36	4.38	4.38	4.34	4.37	4.28	9
	501	BTS 8337	4.18	4.33	4.60	4.68	4.66	4.58	4.64	4.50	4.54	4.36	4.62	6
	577	BTS 8500	4.22	3.76	4.45	4.72	4.04	4.43	4.40	4.34	4.41	4.29	4.54	4
	503	BTS 8524	4.36	4.15	4.18	4.88	4.46	4.16	4.50	4.44	4.54	4.38	4.74	4
	576	BTS 8606	4.40	4.24	4.94	4.92	4.56	4.92	4.80	4.76	4.88	4.73	5.12	3
	527	BTS 8629	4.24	4.03	4.49	4.75	4.33	4.47	4.52	4.40	4.46	4.29	4.59	3
	521	BTS 8735	3.85	3.84	4.22	4.31	4.13	4.20	4.21	4.22	--	4.22	--	2
	512	BTS 8749	3.69	3.69	4.22	4.13	3.97	4.20	4.10	4.08	--	4.05	--	2
	568	BTS 8767	3.87	4.04	4.30	4.33	4.34	4.28	4.32	4.24	--	4.16	--	2
	572	BTS 8784	3.18	3.45	3.94	3.56	3.71	3.93	3.73	3.69	--	3.65	--	2
	529	BTS 8815	4.36	4.06	4.73	4.88	4.37	4.71	4.65	--	--	--	--	1
	505	BTS 8826	4.05	3.77	4.07	4.53	4.05	4.05	4.21	--	--	--	--	1
	536	BTS 8839	3.97	4.02	4.49	4.44	4.32	4.47	4.41	--	--	--	--	1
	516	BTS 8844	4.25	4.36	4.42	4.76	4.69	4.40	4.62	--	--	--	--	1
	531	BTS 8857	4.46	3.60	4.24	4.99	3.87	4.22	4.36	--	--	--	--	1
	554	BTS 8864	3.87	3.98	4.38	4.33	4.28	4.36	4.32	--	--	--	--	1
	535	BTS 8882	4.44	3.91	4.42	4.97	4.21	4.40	4.53	--	--	--	--	1
	553	BTS 8891	4.49	4.12	4.27	5.02	4.43	4.25	4.57	--	--	--	--	1
	530	Crystal 093RR	4.48	4.39	4.91	5.01	4.72	4.89	4.88	4.68	4.77	4.49	4.95	9
	542	Crystal 247RR	4.62	3.79	4.38	5.17	4.08	4.36	4.54	4.55	4.58	4.55	4.65	7
	562	Crystal 355RR	4.12	4.22	4.43	4.61	4.54	4.41	4.52	4.44	4.50	4.36	4.60	6
	513	Crystal 467RR	4.54	3.97	4.49	5.08	4.27	4.47	4.61	4.53	4.58	4.46	4.69	5
	518	Crystal 572RR	3.97	4.00	4.61	4.44	4.30	4.59	4.45	4.36	4.43	4.27	4.57	4
	563	Crystal 573RR	4.03	4.12	4.22	4.51	4.43	4.20	4.38	4.26	4.29	4.15	4.35	4
	575	Crystal 574RR	4.31	3.97	4.17	4.82	4.27	4.15	4.42	4.38	4.43	4.35	4.51	4
	508	Crystal 578RR	4.30	4.32	4.79	4.81	4.65	4.77	4.74	4.83	4.84	4.91	4.87	4
	545	Crystal 684RR	4.57	3.88	3.97	5.11	4.17	3.96	4.41	4.38	4.44	4.34	4.57	3
	522	Crystal 792RR	3.66	4.02	4.39	4.10	4.32	4.37	4.26	4.10	--	3.94	--	2
	557	Crystal 793RR	3.84	3.91	4.30	4.30	4.21	4.28	4.26	4.10	--	3.93	--	2
	574	Crystal 796RR	4.31	4.30	4.78	4.82	4.62	4.76	4.74	4.79	--	4.85	--	2
	519	Crystal 802RR	3.83	4.23	4.55	4.29	4.55	4.53	4.46	--	--	--	--	1
	558	Crystal 803RR	3.69	3.51	4.14	4.13	3.77	4.12	4.01	--	--	--	--	1
	517	Crystal 804RR	4.31	3.65	4.52	4.82	3.93	4.50	4.42	--	--	--	--	1
	550	Crystal 807RR	4.36	4.03	4.26	4.88	4.33	4.24	4.49	--	--	--	--	1
	547	Crystal 808RR	4.27	4.36	5.12	4.78	4.69	5.10	4.86	--	--	--	--	1
	534	Crystal 809RR	4.26	4.44	4.35	4.77	4.77	4.33	4.63	--	--	--	--	1
	580	Hilleshög HM4302RR	3.82	3.86	4.36	4.28	4.15	4.34	4.26	4.09	4.10	3.93	4.13	8
	510	Hilleshög HM4448RR	4.59	4.67	5.63	5.14	5.02	5.61	5.26	5.27	5.25	5.28	5.21	7
	543	Hilleshög HM9528RR	4.44	4.41	4.68	4.97	4.74	4.66	4.79	4.89	4.84	4.99	4.73	6
	560	Hilleshög HIL2230	4.25	4.29	4.77	4.76	4.61	4.75	4.71	--	--	--	--	1
	581	Hilleshög HIL2231	4.57	4.30	4.83	5.11	4.62	4.81	4.85	--	--	--	--	1
	502	Hilleshög HIL2232	4.13	3.95	4.27	4.62	4.25	4.25	4.37	--	--	--	--	1
	566	Hilleshög HIL2233	4.42	4.42	4.92	4.95	4.75	4.90	4.87	--	--	--	--	1
	579	Hilleshög HIL2234	3.85	4.16	4.22	4.31	4.47	4.20	4.33	--	--	--	--	1
	514	Hilleshög HIL2235	3.78	3.72	4.12	4.23	4.00	4.10	4.11	--	--	--	--	1
	506	Hilleshög HIL2236	4.57	4.60	4.71	5.11	4.95	4.69	4.92	--	--	--	--	1
	533	Hilleshög HIL9708	4.22	4.35	4.75	4.72	4.68	4.73	4.71	4.66	4.69	4.61	4.74	4
	525	Hilleshög HIL9920	4.23	4.37	4.97	4.73	4.70	4.95	4.79	4.84	--	4.89	--	2
	541	Maribo MA109	3.85	3.92	4.48	4.31	4.22	4.46	4.33	4.23	4.20	4.14	4.14	5
	532	Maribo MA305	4.18	4.91	4.83	4.68	5.28	4.81	4.92	4.95	4.87	4.98	4.72	6
	515	Maribo MA502	4.29	4.66	5.05	4.80	5.01	5.03	4.95	4.98	4.92	5.01	4.79	4
	504	Maribo MA504	4.34	4.42	5.34	4.86	4.75	5.32	4.98	5.24	5.17	5.50	5.04	4
	567	Maribo MA717	4.33	4.22	4.97	4.85	4.54	4.95	4.78	4.81	--	4.85	--	2
	578	Maribo MA808	4.44	4.87	4.79	4.97	5.24	4.77	4.99	--	--	--	--	1
	509	Maribo MA809	4.17	4.31	4.35	4.67	4.64	4.33	4.55	--	--	--	--	1
	571	Maribo MA810	4.45	5.37	5.34	4.98	5.78	5.32	5.36	--	--	--	--	1
	564	Maribo MA811	4.42	4.40	4.87	4.95	4.73	4.85	4.84	--	--	--	--	1
	556	Maribo MA812	4.41	4.50	4.94	4.94	4.84	4.92	4.90	--	--	--	--	1
	511	SV 284	3.59	3.69	4.24	4.02	3.97	4.22	4.07	--	--	--	--	1
	561	SV 285	4.12	4.21	4.45	4.61	4.53	4.43	4.52	--	--	--	--	1
	526	SV 286	4.60	4.67	5.61	5.15	5.02	5.59	5.25	--	--	--	--	1
	520	SV 287	4.75	4.78	5.39	5.32	5.14	5.37	5.28	--	--	--	--	1
	507	SV 288	4.40	4.40	4.99	4.92	4.73	4.97	4.88	--	--	--	--	1
	523	SV 289	4.21	4.32	4.62	4.71	4.65	4.60	4.65	--	--	--	--	1
	552	SV RR265	4.19	4.01	4.45	4.69	4.31	4.43	4.48	4.83	4.89	5.19	5.00	3
	540	SV RR266	4.30	4.32	4.74	4.81	4.65	4.72	4.73	4.67	4.69	4.61	4.74	3

	548	SV RR268	4.48	4.08	4.72		5.01	4.39	4.70		4.70	4.88	4.97	5.06	5.13	3
	537	SV RR333	4.35	4.14	5.05		4.87	4.45	5.03		4.78	4.81	4.82	4.84	4.85	6
	544	SV RR351	4.31	4.12	4.60		4.82	4.43	4.58		4.61	4.51	4.51	4.41	4.50	4
	582	SV RR371	4.37	4.02	4.93		4.89	4.32	4.91		4.71	4.65	--	4.59	--	2
	555	SV RR375	4.57	4.24	5.24		5.11	4.56	5.22		4.96	5.02	--	5.08	--	2
	538	SX 1885	4.81	4.73	5.51		5.38	5.09	5.49		5.32	--	--	--	--	1
	539	SX 1886	4.37	4.33	4.85		4.89	4.66	4.83		4.79	--	--	--	--	1
	559	SX 1887	4.30	4.57	4.96		4.81	4.91	4.94		4.89	--	--	--	--	1
	546	SX 1888	4.64	4.41	4.84		5.19	4.74	4.82		4.92	--	--	--	--	1
	565	SX 1889	3.46	3.45	4.17		3.87	3.71	4.15		3.91	--	--	--	--	1
	573	SX Avalanche RR	4.21	4.01	4.50		4.71	4.31	4.48		4.50	4.57	4.63	4.64	4.74	4
	569	SX Bronco RR(1863)	4.18	4.25	4.73		4.68	4.57	4.71		4.65	4.37	4.36	4.08	4.35	3
	551	SX Canyon RR	4.33	4.29	4.93		4.85	4.61	4.91		4.79	4.85	4.82	4.92	4.76	5
	549	SX Cruze RR	5.32	5.59	5.41		5.95	6.01	5.39		5.79	5.58	5.27	5.37	4.65	5
	528	SX Marathon RR	4.82	4.66	5.42		5.39	5.01	5.40		5.27	4.90	4.75	4.54	4.44	4
	524	SX RR1879	4.02	4.04	4.49		4.50	4.34	4.47		4.44	4.66	--	4.88	--	2
1	1101	CR CK#19 CRYS539RR	4.55	4.95	5.79		5.09	5.32	5.77		5.39	5.44	5.39	5.49	5.30	14
1	1102	CR CK#24 HILL4012RR	4.71	5.12	5.93		5.27	5.51	5.91		5.56	5.35	5.33	5.13	5.31	13
1	1103	CR CK#28 HILL4010RR	4.63	5.01	5.26		5.18	5.39	5.24		5.27	5.36	5.38	5.44	5.43	13
1	1104	CR CK#48 MARI504	4.41	4.50	5.22		4.94	4.84	5.20		4.99	5.24	5.18	5.50	5.04	4
1	1105	CR CK#49 CRYS578RR	4.39	4.46	4.72		4.91	4.80	4.70		4.80	4.86	4.86	4.91	4.87	4
1	1106	CR CK#41 CRYS981RR	4.46	4.69	4.98		4.99	5.04	4.96		5.00	4.95	4.93	4.90	4.89	10
1	1107	CR CK#50 CRYS101RR	4.14	4.32	4.33		4.63	4.65	4.31		4.53	4.55	4.56	4.57	4.59	8
1	1108	CR CK#43 CRYS246RR	4.61	4.31	4.56		5.16	4.64	4.54		4.78	4.77	4.77	4.77	4.77	7
1	1109	CR CK#44 BETA80RR32	4.63	4.83	4.83		5.18	5.19	4.81		5.06	5.00	5.01	4.94	5.04	9
1	1110	CR CK#45 HILL4448RR	4.60	4.79	5.13		5.15	5.15	5.11		5.14	5.19	5.13	5.24	5.00	7
1	1111	CR CK#51 CRYS355RR	4.16	4.16	4.47		4.66	4.47	4.45		4.53	4.45	4.50	4.36	4.60	6
1	1112	CR CK#47 HILL4094RR	3.89	4.20	4.52		4.35	4.52	4.50		4.46	4.39	4.35	4.31	4.28	11
	1113	CR CK MOD SUS HYB#3	4.72	4.86	5.83		5.28	5.23	5.81		5.44	5.42	5.39	5.41	5.33	14
	1114	CR CK MOD SUS HYB#3	4.66	5.09	5.91		5.22	5.47	5.89		5.53	5.47	5.42	5.41	5.33	14
	1115	CR CK MOD RES HYB#4	3.63	3.96	4.76		4.06	4.26	4.74		4.35	4.28	4.27	4.22	4.24	11
	1116	CR CK MOD RES HYB#4	3.54	3.95	4.49		3.96	4.25	4.47		4.23	4.22	4.23	4.22	4.24	11
	1117	CR CK MOD SUS HYB#5	4.69	4.94	5.34		5.25	5.31	5.32		5.29	5.20	5.13	5.11	4.97	12
		Conventional														
	910	BETA EXP 687	3.49	3.75	3.79		3.90	4.03	3.78		3.90	3.95	4.01	3.99	4.14	3
	918	BETA EXP 698	4.12	3.78	3.87		4.61	4.07	3.86		4.18	4.18	4.21	4.18	4.27	3
	919	BETA EXP 747	3.91	3.85	4.25		4.37	4.14	4.23		4.25	4.32	--	4.40	--	2
	906	BETA EXP 758	3.78	4.27	3.86		4.23	4.59	3.85		4.22	4.37	--	4.52	--	2
	907	BETA EXP 872	4.91	4.46	4.19		5.49	4.79	4.17		4.82	--	--	--	--	1
	903	Crystal 620	4.30	3.86	3.95		4.82	4.15	3.93		4.30	4.22	4.21	4.14	4.19	3
	904	Crystal 840	4.17	4.20	3.80		4.67	4.52	3.79		4.33	--	--	--	--	1
	917	Crystal R761	4.19	4.64	4.50		4.68	4.99	4.48		4.72	4.82	4.88	4.93	4.99	12
	912	Hilleshög HIL2243Rz	3.53	3.79	4.09		3.95	4.08	4.08		4.04	--	--	--	--	1
	911	Hilleshög HM3035Rz	3.75	3.95	4.26		4.20	4.24	4.24		4.23	4.33	4.39	4.42	4.53	14
	909	Hilleshög 9891Rz	3.81	4.01	4.13		4.26	4.31	4.11		4.23	4.18	4.26	4.13	4.42	3
	901	Maribo MA615Rz	4.39	4.03	4.51		4.91	4.33	4.49		4.58	4.70	4.81	4.81	5.04	3
	914	Seedex 8869 Cnv	4.15	4.09	4.95		4.65	4.40	4.93		4.66	4.94	4.88	5.21	4.76	3
	908	Seedex Deuce	4.21	4.16	5.05		4.71	4.48	5.03		4.74	4.75	4.73	4.76	4.68	11
	920	Strube 12720	4.59	4.46	5.70		5.14	4.79	5.68		5.21	5.43	--	5.65	--	2
	905	Strube 12845	3.89	3.78	4.73		4.36	4.06	4.71		4.38	--	--	--	--	1
	913	Strube 12884	4.76	4.43	6.41		5.32	4.76	6.38		5.49	--	--	--	--	1
	915	Strube 13897	4.53	4.09	4.70		5.07	4.40	4.68		4.72	--	--	--	--	1
	902	SV 48611	4.62	4.48	4.89		5.17	4.82	4.87		4.95	5.12	5.03	5.28	4.85	3
	916	SV 48777	4.02	4.07	4.82		4.50	4.38	4.80		4.56	4.66	--	4.76	--	2
	1104	CR CK#48 MARI504	4.29	4.35	5.27		4.80	4.68	5.25		4.91	5.20	5.15	5.50	5.04	4
	1105	CR CK#49 CRYS578RR	4.40	4.83	4.69		4.92	5.20	4.67		4.93	4.92	4.91	4.91	4.87	4
	1106	CR CK#41 CRYS981RR	4.48	4.86	4.62		5.01	5.23	4.61		4.95	4.92	4.91	4.90	4.89	10
	1110	CR CK#45 HILL4448RR	4.69	4.39	5.47		5.25	4.72	5.45		5.14	5.19	5.13	5.24	5.00	7
12		Check Mean	4.43	4.61	4.98		4.96	4.96	4.96		4.96					
		Trial Mean	4.26	4.27	4.72		4.77	4.59	4.70		4.69					
		Coeff. of Var. (%)	3.90	6.32	7.08		3.90	6.32	7.08							
		Mean LSD (0.05)	0.21	0.43	0.41		0.24	0.46	0.41							
		Mean LSD (0.01)	0.28	0.57	0.54		0.31	0.61	0.54							
		Sig Mrk	**	**	**		**	**	**							
		Adj Factor					1.11913	1.07545	0.99624							

* Lower numbers indicate better Cercospora resistance (1-Ex,9=Poor).

++ Ratings adjusted to 1982 basis (5.5 equivalent in 1978-81 CR nurseries). Ratings adjusted on the basis of checks.

Chk = varieties used to adjust CR readings to 1982 basis. Ratings * (Adj. factor) = Adj Rating.

$$ Trial years indicates how many years the entry has been in the official trials.

+ Average rating based upon multiple rating dates.

Created 10-31-2018.

Table 33. 2018 Rhizoctonia Ratings for OVT Entries

Rhizoctonia Nursery - BSDF, NWROC & Two ACSC Sites

Sus				Unadjusted				Adjusted @									
Chk	Chk			BSDF	TSC-E	TSC-W	NWROC	BSDF	TSC-E	TSC-W	NWROC						
^	@	Code	Description	8/24	7/16	7/6		8/24	7/16	7/6		2018	2 Yr	3 Yr	2017	2016	Years
		570	BTS 80RR52	5.89	4.15	3.40	---	4.26	3.81	3.81	---	3.96	4.05	4.17	4.14	4.41	9
		501	BTS 8337	5.71	4.73	3.33	---	4.13	4.35	3.73	---	4.07	4.18	4.15	4.30	4.08	6
		577	BTS 8500	6.25	4.62	3.85	---	4.52	4.25	4.31	---	4.36	4.46	4.45	4.57	4.43	4
		503	BTS 8524	6.20	4.31	3.79	---	4.48	3.96	4.24	---	4.23	4.32	4.28	4.41	4.20	4
		576	BTS 8606	6.38	4.98	3.15	---	4.62	4.58	3.53	---	4.24	4.62	4.57	5.00	4.48	3
		527	BTS 8629	6.01	4.45	3.24	---	4.35	4.09	3.63	---	4.02	4.12	3.99	4.21	3.73	3
		521	BTS 8735	5.60	4.67	3.60	---	4.05	4.29	4.03	---	4.12	4.25	--	4.38	--	2
		512	BTS 8749	5.82	4.59	2.88	---	4.21	4.22	3.22	---	3.88	3.92	--	3.95	--	2
		568	BTS 8767	6.16	4.71	3.13	---	4.46	4.33	3.50	---	4.10	4.42	--	4.75	--	2
		572	BTS 8784	6.22	4.99	4.20	---	4.50	4.59	4.70	---	4.60	4.62	--	4.64	--	2
		529	BTS 8815	5.66	4.30	3.20	---	4.09	3.95	3.58	---	3.88	--	--	--	--	1
		505	BTS 8826	6.07	3.54	2.95	---	4.39	3.25	3.30	---	3.65	--	--	--	--	1
		536	BTS 8839	6.05	4.70	3.35	---	4.38	4.32	3.75	---	4.15	--	--	--	--	1
		516	BTS 8844	6.51	4.27	3.37	---	4.71	3.92	3.77	---	4.14	--	--	--	--	1
		531	BTS 8857	5.53	4.90	3.50	---	4.00	4.50	3.92	---	4.14	--	--	--	--	1
		554	BTS 8864	6.20	5.16	4.84	---	4.48	4.74	5.42	---	4.88	--	--	--	--	1
		535	BTS 8882	6.14	4.47	4.06	---	4.44	4.11	4.55	---	4.37	--	--	--	--	1
		553	BTS 8891	6.02	4.45	2.72	---	4.35	4.09	3.05	---	3.83	--	--	--	--	1
		530	Crystal 093RR	6.43	4.73	4.27	---	4.65	4.35	4.78	---	4.59	4.55	4.49	4.50	4.37	9
		542	Crystal 247RR	6.48	4.81	4.08	---	4.69	4.42	4.57	---	4.56	4.52	4.46	4.49	4.32	7
		562	Crystal 355RR	5.80	3.80	2.93	---	4.20	3.49	3.28	---	3.66	3.87	3.90	4.09	3.96	6
		513	Crystal 467RR	5.97	4.17	3.29	---	4.32	3.83	3.68	---	3.94	4.21	4.23	4.47	4.26	5
		518	Crystal 572RR	6.17	4.76	4.27	---	4.46	4.38	4.78	---	4.54	4.51	4.41	4.47	4.21	4
		563	Crystal 573RR	5.41	5.18	3.76	---	3.91	4.76	4.21	---	4.29	4.43	4.47	4.57	4.55	4
		575	Crystal 574RR	6.12	4.86	3.74	---	4.43	4.47	4.19	---	4.36	4.26	4.33	4.16	4.47	4
		508	Crystal 578RR	6.21	4.87	3.50	---	4.49	4.48	3.92	---	4.30	4.35	4.34	4.40	4.32	4
		545	Crystal 684RR	6.55	4.59	3.75	---	4.74	4.22	4.20	---	4.39	4.48	4.46	4.57	4.41	3
		522	Crystal 792RR	5.84	4.59	3.76	---	4.22	4.22	4.21	---	4.22	4.05	--	3.88	--	2
		557	Crystal 793RR	5.60	4.83	3.43	---	4.05	4.44	3.84	---	4.11	4.18	--	4.26	--	2
		574	Crystal 796RR	6.17	4.41	3.03	---	4.46	4.05	3.39	---	3.97	4.10	--	4.23	--	2
		519	Crystal 802RR	6.11	4.56	3.87	---	4.42	4.19	4.33	---	4.31	--	--	--	--	1
		558	Crystal 803RR	6.44	5.19	4.09	---	4.66	4.77	4.58	---	4.67	--	--	--	--	1
		517	Crystal 804RR	6.12	4.21	3.37	---	4.43	3.87	3.77	---	4.02	--	--	--	--	1
		550	Crystal 807RR	6.08	4.57	3.42	---	4.40	4.20	3.83	---	4.14	--	--	--	--	1
		547	Crystal 808RR	5.81	4.29	3.00	---	4.20	3.94	3.36	---	3.83	--	--	--	--	1
		534	Crystal 809RR	6.48	4.63	3.77	---	4.69	4.26	4.22	---	4.39	--	--	--	--	1
		580	Hilleshög HM4302RR	5.90	3.71	3.09	---	4.27	3.41	3.46	---	3.71	3.65	3.65	3.60	3.65	8
		510	Hilleshög HM4448RR	5.99	4.76	3.95	---	4.33	4.38	4.42	---	4.38	4.50	4.51	4.63	4.51	7
		543	Hilleshög HM9528RR	5.68	4.56	3.42	---	4.11	4.19	3.83	---	4.04	4.13	4.16	4.21	4.21	6
		560	Hilleshög HIL2230	6.18	4.65	3.07	---	4.47	4.27	3.44	---	4.06	--	--	--	--	1
		581	Hilleshög HIL2231	6.15	4.82	4.00	---	4.45	4.43	4.48	---	4.45	--	--	--	--	1
		502	Hilleshög HIL2232	6.06	4.04	3.27	---	4.38	3.71	3.66	---	3.92	--	--	--	--	1
		566	Hilleshög HIL2233	5.87	4.50	3.34	---	4.25	4.14	3.74	---	4.04	--	--	--	--	1
		579	Hilleshög HIL2234	5.98	3.73	3.22	---	4.33	3.43	3.60	---	3.79	--	--	--	--	1
		514	Hilleshög HIL2235	6.42	5.09	4.42	---	4.64	4.68	4.95	---	4.76	--	--	--	--	1
		506	Hilleshög HIL2236	5.94	4.40	3.71	---	4.30	4.04	4.15	---	4.16	--	--	--	--	1
		533	Hilleshög HIL9708	5.83	4.25	2.68	---	4.22	3.91	3.00	---	3.71	3.96	4.07	4.21	4.28	4
		525	Hilleshög HIL9920	6.13	5.28	4.16	---	4.43	4.85	4.66	---	4.65	4.56	--	4.48	--	2
		541	Maribo MA109	5.69	3.65	3.21	---	4.12	3.36	3.59	---	3.69	3.66	3.67	3.63	3.69	5
		532	Maribo MA305	6.35	4.61	3.53	---	4.59	4.24	3.95	---	4.26	4.43	4.42	4.60	4.40	6
		515	Maribo MA502	6.10	4.56	3.56	---	4.41	4.19	3.99	---	4.20	4.49	4.57	4.78	4.73	4
		504	Maribo MA504	5.84	4.58	3.85	---	4.22	4.21	4.31	---	4.25	4.31	4.40	4.37	4.58	4
		567	Maribo MA717	6.23	4.68	3.78	---	4.51	4.30	4.23	---	4.35	4.31	--	4.28	--	2
		578	Maribo MA808	6.07	4.74	3.24	---	4.39	4.36	3.63	---	4.12	--	--	--	--	1
		509	Maribo MA809	5.98	3.82	3.34	---	4.33	3.51	3.74	---	3.86	--	--	--	--	1
		571	Maribo MA810	6.52	5.14	4.25	---	4.72	4.72	4.76	---	4.73	--	--	--	--	1
		564	Maribo MA811	6.34	4.85	3.90	---	4.59	4.46	4.37	---	4.47	--	--	--	--	1
		556	Maribo MA812	5.70	4.33	3.30	---	4.12	3.98	3.69	---	3.93	--	--	--	--	1
		511	SV 284	5.88	4.58	3.63	---	4.25	4.21	4.06	---	4.18	--	--	--	--	1
		561	SV 285	6.21	4.56	3.91	---	4.49	4.19	4.38	---	4.35	--	--	--	--	1
		526	SV 286	5.77	4.92	4.13	---	4.17	4.52	4.62	---	4.44	--	--	--	--	1
		520	SV 287	6.07	4.61	3.37	---	4.39	4.24	3.77	---	4.13	--	--	--	--	1
		507	SV 288	5.98	4.59	3.70	---	4.33	4.22	4.14	---	4.23	--	--	--	--	1
		523	SV 289	5.83	4.82	3.98	---	4.22	4.43	4.46	---	4.37	--	--	--	--	1
		552	SV RR265	6.36	4.81	3.53	---	4.60	4.42	3.95	---	4.32	4.37	4.39	4.42	4.44	3
		540	SV RR266	5.72	4.76	4.03	---	4.14	4.38	4.51	---	4.34	4.36	4.31	4.39	4.20	3
		548	SV RR268	5.94	4.81	3.50	---	4.30	4.42	3.92	---	4.21	4.39	4.49	4.57	4.70	3
		537	SV RR333	6.02	4.97	3.37	---	4.35	4.57	3.77	---	4.23	4.34	4.37	4.44	4.44	6
		544	SV RR351	5.79	4.60	3.63	---	4.19	4.23	4.06	---	4.16	4.20	4.19	4.25	4.17	4
		582	SV RR371	5.56	4.56	3.90	---	4.02	4.19	4.37	---	4.19	4.25	--	4.31	--	2
		555	SV RR375	5.99	4.79	3.26	---	4.33	4.40	3.65	---	4.13	4.19	--	4.25	--	2

		538	SX 1885	6.10	4.68	3.79	---	4.41	4.30	4.24	---	4.32	--	--	--	--	1
		539	SX 1886	6.15	4.70	3.61	---	4.45	4.32	4.04	---	4.27	--	--	--	--	1
		559	SX 1887	5.98	4.72	3.42	---	4.33	4.34	3.83	---	4.16	--	--	--	--	1
		546	SX 1888	5.92	4.61	4.63	---	4.28	4.24	5.18	---	4.57	--	--	--	--	1
		565	SX 1889	6.22	4.80	4.57	---	4.50	4.41	5.12	---	4.68	--	--	--	--	1
		573	SX Avalanche RR	6.00	5.12	3.60	---	4.34	4.71	4.03	---	4.36	4.33	4.39	4.29	4.52	4
		569	SX Bronco RR(1863)	6.22	5.32	4.28	---	4.50	4.89	4.79	---	4.73	4.48	4.50	4.23	4.54	3
		551	SX Canyon RR	6.05	4.73	3.88	---	4.38	4.35	4.34	---	4.36	4.43	4.42	4.51	4.40	5
		549	SX Cruze RR	6.11	4.57	3.63	---	4.42	4.20	4.06	---	4.23	4.31	4.44	4.39	4.69	5
		528	SX Marathon RR	6.16	4.70	3.38	---	4.46	4.32	3.78	---	4.19	4.29	4.35	4.40	4.47	4
		524	SX RR1879	5.90	4.50	4.07	---	4.27	4.14	4.56	---	4.32	4.34	--	4.36	--	2
1	1	1301	RH CK#08 CRYS539RR	6.09	5.11	4.41	---	4.41	4.70	4.94	---	4.68	4.71	4.75	4.74	4.84	10
1	1	1302	RH CK#51 SXWinchester	6.11	4.87	4.11	---	4.42	4.48	4.60	---	4.50	4.49	4.53	4.47	4.63	6
1	1	1303	RH CK#21 CRYS768RR	6.42	4.60	4.18	---	4.64	4.23	4.68	---	4.52	4.59	4.50	4.66	4.32	10
1	1	1304	RH CK#25 HILL4043RR	6.39	5.36	4.42	---	4.62	4.93	4.95	---	4.83	4.67	4.70	4.51	4.76	10
	1	1305	RH CK#28 CRYS658RR	6.10	4.19	3.38	---	4.41	3.85	3.78	---	4.02	4.19	4.32	4.36	4.57	13
1	1	1306	RH CK#52 CRYS573RR	6.25	4.88	3.95	---	4.52	4.49	4.42	---	4.48	4.52	4.53	4.57	4.55	4
	1	1307	RH CK#53 BTS8500	5.95	4.54	4.01	---	4.30	4.17	4.49	---	4.32	4.44	4.44	4.57	4.43	4
	1	1308	RH CK#35 SES36812RR	6.21	4.73	3.61	---	4.49	4.35	4.04	---	4.29	4.50	4.52	4.71	4.55	11
	1	1309	RH CK#36 BTS85RR02	5.61	5.19	4.07	---	4.06	4.77	4.56	---	4.46	4.28	4.34	4.10	4.45	14
	1	1310	RH CK#37 SES36918RR	5.89	4.64	3.97	---	4.26	4.27	4.44	---	4.32	4.38	4.47	4.43	4.67	10
	1	1311	RH CK#40 CRYS101RR	6.42	5.09	3.72	---	4.64	4.68	4.16	---	4.50	4.52	4.57	4.55	4.65	8
1	1	1312	RH CK#45 BTS82RR33	6.13	5.03	4.51	---	4.43	4.62	5.05	---	4.70	4.72	4.54	4.73	4.19	7
	1	1313	RH CK#47 SES36272RR	6.18	4.95	3.63	---	4.47	4.55	4.06	---	4.36	4.49	4.49	4.62	4.50	7
	1	1314	RH CK#48 HILL4094RR	5.61	4.18	2.90	---	4.06	3.84	3.25	---	3.72	3.76	3.80	3.80	3.90	11
1	1	1315	RH CK#49 CRYS247RR	6.30	4.79	4.37	---	4.56	4.40	4.89	---	4.62	4.63	4.55	4.65	4.38	7
		1316	RES RHC #1	4.99	3.94	2.89	---	3.61	3.62	3.24	---	3.49	3.56	3.65	3.62	3.83	13
		1317	MOD RHC #6	5.86	4.62	3.44	---	4.24	4.25	3.85	---	4.11	4.39	4.37	4.68	4.32	13
		1318	SUS RHC #3	6.29	5.31	4.20	---	4.55	4.88	4.70	---	4.71	4.67	4.70	4.64	4.74	14
		1319	SUS RHC #9	6.17	4.72	4.04	---	4.46	4.34	4.52	---	4.44	4.46	4.49	4.47	4.57	10
		1320	MOD RHC #5	5.98	5.10	3.81	---	4.33	4.69	4.27	---	4.43	4.38	4.49	4.34	4.71	13
		1321	RES RHC #3	4.90	3.96	2.58	---	3.54	3.64	2.89	---	3.36	3.49	3.56	3.63	3.69	5
		1322	SUS RHC #3	6.33	5.11	4.26	---	4.58	4.70	4.77	---	4.68	4.66	4.69	4.64	4.74	14
		1323	SUS RHC #10	6.01	5.16	3.97	---	4.35	4.74	4.44	---	4.51	4.39	4.51	4.28	4.75	10
			Conventional														
		910	BETA EXP 687	5.98	4.06	3.11	---	4.33	3.73	3.48	---	3.85	4.02	4.07	4.20	4.16	3
		918	BETA EXP 698	6.28	4.54	3.53	---	4.54	4.17	3.96	---	4.22	4.34	4.34	4.45	4.35	3
		919	BETA EXP 747	5.84	4.25	3.73	---	4.22	3.91	4.17	---	4.10	4.01	--	3.93	--	2
		906	BETA EXP 758	5.86	3.89	3.68	---	4.24	3.57	4.12	---	3.98	4.14	--	4.31	--	2
		907	BETA EXP 872	6.06	4.78	3.98	---	4.38	4.39	4.45	---	4.41	--	--	--	--	1
		903	Crystal 620	6.12	4.50	3.48	---	4.43	4.13	3.89	---	4.15	4.26	4.35	4.37	4.54	3
		904	Crystal 840	5.65	4.55	3.44	---	4.09	4.18	3.85	---	4.04	--	--	--	--	1
		917	Crystal R761	6.09	4.85	3.75	---	4.41	4.46	4.20	---	4.36	4.45	4.49	4.54	4.57	12
		912	Hilleshög HIL2243Rz	6.54	5.25	4.81	---	4.73	4.82	5.39	---	4.98	--	--	--	--	1
		911	Hilleshög HM3035Rz	5.78	4.34	3.46	---	4.18	3.99	3.87	---	4.01	4.04	4.00	4.07	3.93	14
		909	Hilleshög 9891Rz	5.77	3.82	3.22	---	4.17	3.51	3.60	---	3.76	4.11	4.15	4.46	4.22	3
		901	Maribo MA615Rz	6.18	4.60	3.95	---	4.47	4.23	4.42	---	4.37	4.55	4.55	4.73	4.54	3
		914	Seedex 8869 Cnv	6.13	4.93	4.22	---	4.43	4.53	4.72	---	4.56	4.48	4.54	4.40	4.67	3
		908	Seedex Deuce	6.42	4.85	3.99	---	4.65	4.46	4.47	---	4.53	4.46	4.52	4.39	4.66	11
		920	Strube 12720	6.57	4.95	5.53	---	4.75	4.55	6.19	---	5.17	4.88	--	4.59	--	2
		905	Strube 12845	6.30	4.83	4.60	---	4.55	4.44	5.15	---	4.71	--	--	--	--	1
		913	Strube 12884	6.42	5.48	5.65	---	4.65	5.04	6.32	---	5.33	--	--	--	--	1
		915	Strube 13897	6.08	4.99	4.50	---	4.40	4.59	5.04	---	4.68	--	--	--	--	1
		902	SV48611	6.04	4.81	4.30	---	4.37	4.42	4.82	---	4.54	4.44	4.52	4.35	4.66	3
		916	SV48777	6.27	5.02	3.85	---	4.53	4.62	4.31	---	4.49	4.54	--	4.59	--	2
		1301	RH CK#08 CRYS539RR	6.24	5.20	4.74	---	4.51	4.78	5.31	---	4.87	4.80	4.82	4.74	4.84	10
		1302	RH CK#51 SXWinchester	6.29	4.81	4.10	---	4.55	4.42	4.59	---	4.52	4.50	4.54	4.47	4.63	6
		1306	RH CK#52 CRYS573RR	6.19	5.04	3.99	---	4.48	4.64	4.46	---	4.52	4.55	4.55	4.57	4.55	4
		1311	RH CK#40 CRYS101RR	6.16	4.90	3.36	---	4.46	4.51	3.76	---	4.24	4.40	4.48	4.55	4.65	8
	15		Mean of Check Varieties	6.111	4.810	3.949	---	4.420	4.421	4.421	---	4.468	4.501	4.518	4.534	4.552	
7			Mean of Susc Checks	6.241	4.949	4.279	---	4.515	4.549	4.790	---	4.618	4.616	4.594	4.614	4.548	
			Trial Mean	6.03	4.64	3.67	---	4.36	4.27	4.11	---						
			Coeff. of Var. (%)	7.51	7.37	12.44	---	7.51	7.37	12.44	---						
			Mean LSD (0.05)	0.62	0.42	0.73	---	0.45	0.39	0.82	---						
			Mean LSD (0.01)	0.82	0.55	0.96	---	0.59	0.51	1.07	---						
			Sig Lvl	**	**	**	---	**	**	**	---						
			Adjustment Factor	0.7234	0.9192	1.1195	---				---						
			Approval Limit (80% of susc chec	4.99	3.96	3.42	---	3.61	3.64	3.83	---	3.69	3.69	3.67	3.69	3.64	
			++ Adjustment is based upon check varieties.														
			@ Ratings adjusted to 2009 basis (2007-2009) RH nurseries. Ratings adjusted on the basis of checks														
			Lower numbers indicate better tolerance (0=Ex, 7=Poor).														
			^ Approval criteria is based upon the mean of susc varieties (approval option 1) or 3.82 (approval option 2).														

Table 34.

2018 Fusarium Ratings for Official Trial Entries

ACSC Nurseries - (Two Moorhead, MN Sites)

Chk			Unadjusted		Adjusted						
			N Mhd	S Mhd	N Mhd	S Mhd					
@	Code	Description	1 Dates+	4 Dates+	1 Dates+	4 Dates+	2018	2 Yr	3 Yr	2017	2016	Years
	570	BTS 80RR52	6.23	4.78	4.01	3.50	3.76	3.22	3.08	2.69	2.81	9
	501	BTS 8337	7.02	5.24	4.52	3.84	4.18	4.00	4.01	3.83	4.01	6
	577	BTS 8500	3.61	3.54	2.33	2.59	2.46	2.30	2.17	2.14	1.90	4
	503	BTS 8524	6.36	5.15	4.10	3.77	3.93	3.59	3.52	3.24	3.38	4
	576	BTS 8606	5.88	4.82	3.79	3.53	3.66	3.24	3.05	2.81	2.69	3
	527	BTS 8629	7.25	5.63	4.67	4.12	4.40	4.30	4.21	4.20	4.04	3
	521	BTS 8735	6.58	5.24	4.24	3.84	4.04	3.98	--	3.93	--	2
	512	BTS 8749	6.59	4.54	4.25	3.32	3.79	3.53	--	3.28	--	2
	568	BTS 8767	5.17	4.76	3.33	3.49	3.41	3.06	--	2.71	--	2
	572	BTS 8784	5.75	5.22	3.71	3.82	3.76	3.20	--	2.63	--	2
	529	BTS 8815	5.58	5.02	3.60	3.68	3.64	--	--	--	--	1
	505	BTS 8826	4.40	4.15	2.84	3.04	2.94	--	--	--	--	1
	536	BTS 8839	5.86	4.87	3.78	3.57	3.67	--	--	--	--	1
	516	BTS 8844	5.02	3.58	3.24	2.62	2.93	--	--	--	--	1
	531	BTS 8857	8.31	7.12	5.36	5.21	5.28	--	--	--	--	1
	554	BTS 8864	6.16	5.78	3.97	4.23	4.10	--	--	--	--	1
	535	BTS 8882	5.26	4.62	3.39	3.38	3.39	--	--	--	--	1
	553	BTS 8891	4.88	4.90	3.14	3.59	3.37	--	--	--	--	1
	530	Crystal 093RR	6.44	6.02	4.15	4.41	4.28	3.88	3.70	3.48	3.35	9
	542	Crystal 247RR	5.09	4.64	3.28	3.40	3.34	3.17	3.05	3.00	2.80	7
	562	Crystal 355RR	5.85	5.04	3.77	3.69	3.73	3.24	3.05	2.76	2.65	6
	513	Crystal 467RR	3.88	4.55	2.50	3.33	2.92	2.45	2.25	1.98	1.84	5
	518	Crystal 572RR	5.55	5.21	3.58	3.81	3.70	3.17	2.72	2.64	1.82	4
	563	Crystal 573RR	6.26	5.96	4.03	4.36	4.20	3.65	3.60	3.10	3.49	4
	575	Crystal 574RR	4.07	4.27	2.62	3.13	2.87	2.55	2.31	2.23	1.82	4
	508	Crystal 578RR	5.74	4.13	3.70	3.02	3.36	2.88	2.59	2.41	1.99	4
	545	Crystal 684RR	4.62	4.03	2.98	2.95	2.96	2.49	2.25	2.01	1.76	3
	522	Crystal 792RR	5.42	4.80	3.49	3.51	3.50	3.16	--	2.81	--	2
	557	Crystal 793RR	5.84	4.67	3.76	3.42	3.59	3.27	--	2.95	--	2
	574	Crystal 796RR	5.46	4.36	3.52	3.19	3.36	2.85	--	2.34	--	2
	519	Crystal 802RR	5.68	4.76	3.66	3.49	3.57	--	--	--	--	1
	558	Crystal 803RR	6.57	5.45	4.23	3.99	4.11	--	--	--	--	1
	517	Crystal 804RR	4.67	4.22	3.01	3.09	3.05	--	--	--	--	1
	550	Crystal 807RR	6.81	5.68	4.39	4.16	4.27	--	--	--	--	1
	547	Crystal 808RR	5.21	3.94	3.36	2.88	3.12	--	--	--	--	1
	534	Crystal 809RR	4.67	3.39	3.01	2.48	2.75	--	--	--	--	1
	580	Hilleshög HM4302RR	8.26	6.45	5.32	4.72	5.02	5.06	5.07	5.09	5.09	8
	510	Hilleshög HM4448RR	8.39	6.90	5.41	5.05	5.23	5.29	5.28	5.35	5.26	7
	543	Hilleshög HM9528RR	8.03	6.46	5.17	4.73	4.95	4.60	4.57	4.25	4.52	6
	560	Hilleshög HIL2230	8.13	6.13	5.24	4.49	4.86	--	--	--	--	1
	581	Hilleshög HIL2231	7.92	6.72	5.10	4.92	5.01	--	--	--	--	1
	502	Hilleshög HIL2232	6.74	5.84	4.34	4.28	4.31	--	--	--	--	1
	566	Hilleshög HIL2233	8.15	7.24	5.25	5.30	5.28	--	--	--	--	1
	579	Hilleshög HIL2234	7.51	6.21	4.84	4.55	4.69	--	--	--	--	1
	514	Hilleshög HIL2235	7.36	6.79	4.74	4.97	4.86	--	--	--	--	1
	506	Hilleshög HIL2236	8.32	7.41	5.36	5.43	5.39	--	--	--	--	1
	533	Hilleshög HIL9708	7.07	6.38	4.56	4.67	4.61	4.61	4.50	4.61	4.29	4
	525	Hilleshög HIL9920	8.66	7.44	5.58	5.45	5.51	5.72	--	5.92	--	2

	541	Maribo MA109	7.80	6.65		5.03	4.87		4.95	4.59	4.56	4.23	4.50	5
	532	Maribo MA305	8.80	7.15		5.67	5.24		5.45	5.67	5.74	5.89	5.89	6
	515	Maribo MA502	4.66	4.99		3.00	3.65		3.33	3.17	2.76	3.02	1.92	4
	504	Maribo MA504	7.43	6.56		4.79	4.80		4.80	4.66	4.64	4.52	4.60	4
	567	Maribo MA717	7.78	6.44		5.01	4.72		4.86	4.91	--	4.95	--	2
	578	Maribo MA808	7.00	6.26		4.51	4.58		4.55	--	--	--	--	1
	509	Maribo MA809	7.06	6.09		4.55	4.46		4.50	--	--	--	--	1
	571	Maribo MA810	7.77	6.80		5.01	4.98		4.99	--	--	--	--	1
	564	Maribo MA811	7.30	5.86		4.70	4.29		4.50	--	--	--	--	1
	556	Maribo MA812	7.62	6.46		4.91	4.73		4.82	--	--	--	--	1
	511	SV 284	7.43	6.33		4.79	4.63		4.71	--	--	--	--	1
	561	SV 285	8.83	7.03		5.69	5.15		5.42	--	--	--	--	1
	526	SV 286	7.81	6.96		5.03	5.10		5.06	--	--	--	--	1
	520	SV 287	8.08	6.86		5.21	5.02		5.11	--	--	--	--	1
	507	SV 288	6.91	6.25		4.45	4.58		4.51	--	--	--	--	1
	523	SV 289	8.57	7.34		5.52	5.37		5.45	--	--	--	--	1
	552	SV RR265	8.35	7.51		5.38	5.50		5.44	5.38	5.34	5.32	5.26	3
	540	SV RR266	8.73	7.98		5.63	5.84		5.73	5.69	5.52	5.64	5.18	3
	548	SV RR268	7.76	7.15		5.00	5.24		5.12	5.06	5.11	5.01	5.20	3
	537	SV RR333	8.10	6.92		5.22	5.07		5.14	5.24	5.11	5.35	4.84	6
	544	SV RR351	8.19	7.26		5.28	5.32		5.30	5.13	5.00	4.96	4.75	4
	582	SV RR371	8.43	7.22		5.43	5.29		5.36	5.13	--	4.91	--	2
	555	SV RR375	8.59	7.48		5.54	5.48		5.51	5.47	--	5.44	--	2
	538	SX 1885	8.78	7.42		5.66	5.43		5.55	--	--	--	--	1
	539	SX 1886	7.80	6.62		5.03	4.85		4.94	--	--	--	--	1
	559	SX 1887	8.62	7.02		5.56	5.14		5.35	--	--	--	--	1
	546	SX 1888	8.26	7.67		5.32	5.62		5.47	--	--	--	--	1
	565	SX 1889	7.02	6.59		4.52	4.83		4.67	--	--	--	--	1
	573	SX Avalanche RR	8.61	7.10		5.55	5.20		5.37	5.56	5.50	5.75	5.38	4
	569	SX Bronco RR(1863)	8.42	7.67		5.43	5.62		5.52	5.78	5.79	6.04	5.80	3
	551	SX Canyon RR	7.88	6.53		5.08	4.78		4.93	5.03	5.10	5.12	5.26	5
	549	SX Cruze RR	7.93	6.09		5.11	4.46		4.78	4.38	3.85	3.98	2.80	5
	528	SX Marathon RR	8.62	7.47		5.56	5.47		5.51	5.18	5.08	4.84	4.90	4
	524	SX RR1879	8.07	7.06		5.20	5.17		5.18	4.91	--	4.64	--	2
1	1201	FS CK #07 CRYS658RR	5.46	4.83		3.52	3.54		3.53	3.19	3.01	2.85	2.66	13
1	1202	FS CK #08 HILL4000RR	8.64	8.26		5.57	6.05		5.81	6.20	6.18	6.59	6.15	12
1	1203	FS CK #09 HILL4010RR	8.97	8.24		5.78	6.03		5.91	6.16	6.25	6.41	6.42	13
1	1204	FS CK #12 HILL4012RR	8.87	7.70		5.72	5.64		5.68	5.78	5.91	5.89	6.15	13
1	1205	FS CK #13 HILL4043RR	8.63	8.05		5.56	5.89		5.73	6.02	6.03	6.31	6.05	12
1	1206	FS CK #30 BTS8337	7.09	5.76		4.57	4.22		4.39	4.11	4.08	3.83	4.01	6
1	1207	FS CK #18 CRYS768RR	7.77	6.41		5.01	4.69		4.85	4.61	4.54	4.37	4.40	10
1	1208	FS CK #31 SXMarathon	7.54	6.69		4.86	4.90		4.88	4.86	4.87	4.84	4.90	4
1	1209	FS CK #28 SES36918RR	8.14	7.56		5.25	5.54		5.39	5.22	5.19	5.04	5.13	10
1	1210	FS CK #29 CRYS875RR	8.41	6.44		5.42	4.72		5.07	4.92	4.84	4.77	4.68	11
	1211	FS CHK RES RR #1	5.16	4.99		3.33	3.65		3.49	3.11	2.86	2.73	2.37	8
	1212	FS CHK SUS RR #2	8.91	7.99		5.74	5.85		5.80	6.08	6.10	6.37	6.12	8
	1213	FS CHK MOD RR RES #2	7.28	5.96		4.69	4.36		4.53	4.44	4.35	4.35	4.17	12
	1214	FS CHK MOD RR SUS #1	8.10	6.93		5.22	5.07		5.15	4.88	5.00	4.61	5.23	12
	1215	FS CHK RES RR #2	4.91	4.41		3.16	3.23		3.20	2.80	2.55	2.40	2.04	7
	1216	FS CHK SUS RR #10	8.00	7.09		5.16	5.19		5.17	5.18	5.25	5.20	5.38	5
	1217	FS CHK SUS RR #11	8.39	7.25		5.41	5.31		5.36	5.48	5.62	5.61	5.89	6

		Conventional												
	910	BETA EXP 687	5.35	5.93		3.45	4.34		3.90	3.70	3.60	3.51	3.41	3
	918	BETA EXP 698	4.55	4.88		2.93	3.58		3.25	3.16	3.02	3.06	2.74	3
	919	BETA EXP 747	7.57	6.17		4.88	4.51		4.70	4.64	--	4.58	--	2
	906	BETA EXP 758	6.02	6.18		3.88	4.52		4.20	4.06	--	3.91	--	2
	907	BETA EXP 872	5.47	5.26		3.52	3.85		3.69	--	--	--	--	1
	903	Crystal 620	5.38	4.75		3.46	3.47		3.47	3.13	3.00	2.79	2.73	3
	904	Crystal 840	5.44	4.95		3.51	3.62		3.56	--	--	--	--	1
	917	Crystal R761	5.85	6.09		3.77	4.46		4.11	3.67	3.53	3.23	3.25	12
	912	Hilleshög HIL2243Rz	8.90	6.99		5.74	5.12		5.43	--	--	--	--	1
	911	Hilleshög HM3035Rz	7.91	5.20		5.10	3.81		4.45	4.07	3.93	3.70	3.65	14
	909	Hilleshög 9891Rz	5.79	4.68		3.73	3.43		3.58	3.62	3.67	3.66	3.76	3
	901	Maribo MA615Rz	7.84	6.44		5.05	4.72		4.88	4.80	4.91	4.72	5.11	3
	914	Seedex 8869 Cnv	6.02	5.00		3.88	3.66		3.77	3.65	3.41	3.53	2.92	3
	908	Seedex Deuce	7.93	6.78		5.11	4.96		5.04	4.79	4.75	4.54	4.68	11
	920	Strube 12720	9.00	7.39		5.80	5.41		5.61	5.60	--	5.60	--	2
	905	Strube 12845	7.35	6.86		4.74	5.02		4.88	--	--	--	--	1
	913	Strube 12884	8.50	6.47		5.48	4.74		5.11	--	--	--	--	1
	915	Strube 13897	9.00	7.90		5.80	5.79		5.79	--	--	--	--	1
	902	SV 48611	8.83	7.71		5.69	5.64		5.67	5.70	5.55	5.74	5.24	3
	916	SV 48777	6.72	6.24		4.33	4.57		4.45	4.21	--	3.96	--	2
	1201	FS CK #07 CRYS658RR	5.55	5.36		3.58	3.92		3.75	3.30	3.09	2.85	2.66	13
	1205	FS CK #13 HILL4043RR	8.50	7.34		5.48	5.37		5.42	5.86	5.92	6.31	6.05	12
	1208	FS CK #31 SXMarathon	8.08	7.03		5.21	5.15		5.18	5.01	4.97	4.84	4.90	4
	1210	FS CK #29 CRYS875RR	7.91	6.29		5.10	4.60		4.85	4.81	4.77	4.77	4.68	11
10		Check Mean	7.95	6.99		5.12	5.12		5.12					
		Trial Mean	7.05	6.07		4.54	4.44		4.49					
		Coeff. of Var. (%)	7.34	9.44		7.34	9.44							
		Mean LSD (0.05)	0.66	0.75		0.43	0.55							
		Mean LSD (0.01)	0.87	0.99		0.56	0.72							
		Sig Mrk	**	**		**	**							
		Adj Factor				0.64444	0.73219							
		@ Ratings adjusted to 2007 basis. (2005-2006 FS Nurseries). Ratings adjusted on the basis of checks.												
		+ Average rating based upon multiple rating dates. Lower numbers indicate better tolerance (1=Ex, 9=Poor).												

Table 35. Herbicides and Fungicides Applied to ACSC Official Trials

	Herbicide			Fungicide		
Location	Herbicide & Rate	Spray Dates	Method	Fungicide Used	Spray Dates	Method
Casselton	RU1	5/31	Ground	Quadris	6/4,6/21	Ground
	RU2	6/19	Ground	CR.1/CR.2/CR.3	7/13,7/24,8/6	Ground
	Conventional	5/26	Ground			
Glyndon	RU1	5/29	Ground	Quadris	6/1,6/20	Ground
	RU2	6/19	Ground	CR.1/CR.2/CR.3	7/9,7/24,8/6	Ground
Georgetown	RU1	6/7	Ground	Quadris	6/9,6/21	Ground
	RU2	6/27	Ground	CR.1/CR.2/CR.3	7/9,7/24,8/6	Ground
Ada	RU1	5/29	Ground	Quadris	6/1,6/20	Ground
	RU2	6/19	Ground	CR.1/CR.2/CR.3/CR.4	7/10,7/27,8/15,9/5	Air
	Conventional	5/26,6/4	Ground			
Hillsboro	RU1	5/29	Ground	Quadris	6/4,6/20	Ground
	RU2	6/19	Ground	CR.1/CR.2/CR.3/CR.4	7/10,7/27,8/15,9/5	Air
Climax	RU1	5/25	Ground	Quadris	6/8,6/23	Ground
	RU2	6/18	Ground	CR.1/CR.2/CR.3	7/13,7/25,8/8	Ground
Grand Forks + #	RU1	6/7	Ground	Quadris	6/8,6/23	Ground
	RU2	6/26	Ground	CR.1/CR.2/CR.3	7/13,7/27,8/8	Ground
	Conventional	6/4	Ground			
Scandia	RU1	5/26	Ground	Quadris	5/30,6/18	Ground
	RU2	6/18	Ground	CR.1/CR.2/CR.3	7/13,7/25,8/8	Ground
	Conventional	5/26	Ground			
East Grand Forks#	RU1	5/30	Ground	Quadris	5/30,6/18	Ground
	RU2	6/19	Ground	CR.1/CR.2/CR.3	7/12,7/27,8/10	Ground
Stephen	RU1	5/29	Ground	Quadris	5/31,6/22	Ground
	RU2	6/19	Ground	CR.1/CR.2/CR.3	7/18,8/3,8/16	Ground
St. Thomas+^	RU1	5/30	Ground	Quadris	5/31,6/19	Ground
	RU2	6/18	Ground	CR.1/CR.2/CR.3/CR.4	7/18,8/3,8/16,8/29	Ground
	Conventional	5/26,6/13	Ground			
Bathgate#	RU1	5/26	Ground	Quadris	5/31,6/19	Ground
	RU2	6/18	Ground	CR.1/CR.2/CR.3	7/18,8/3,8/16	Ground

Ground applications made by beet seed personnel from Crystal Technical Services Center.

RU1 = Roundup Powermax (28 oz./A), Event (1 gal./100 gal water).

RU2 = Roundup Powermax (22 oz./A), Event (1 gal./100 gal water).

+ Counter 20G applied at 9.0 lbs./A at Grand Forks & St Thomas.

^ Thimet applied at St Thomas near peak fly in early June.

Lorsban 4E applied near peak fly in early June.

Quadris=first application on 2 leaf beets, second on 4-8 leaf beets.

CR.1=Insire XT + Penncozeb

CR.2=Agritin + Incognito

CR.3=Proline+Penncozeb

CR.4=Headline + Agritin

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