PROGRESS REPORT ON GRASS SEED PRODUCTION RESEARCH

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This summary and previous annual research summaries are on the Web at:
http://www.mnturfseed.org/html/progress_reports.html

Standard Management Practices for University of Minnesota
Grass Seed Production Research Plots

General management regime of perennial ryegrass plots on the Magnusson Research Farm:

Spring seeded ryegrass with wheat

Ryegrass seeded at 5-7#/acre with spring wheat
Sterling Blue+ 2,4-D amine 4 (0.75 + 0.75 pint) applied in mid-September
Fertilize 30-30-30 mid-September after small grain harvest
Spike tooth harrow after fall fertilizer application to spread straw
Fertilize 110-0-0 applied early to mid-May, 300 - 600 GDD
Sterling Blue+ 2,4-D amine 4 (0.75+0.75 pint) applied late May, 700 - 900 GDD
Tecoma or Assure II (8-10 oz) applied early June, 800 - 1,000 GDD
Apogee (8 oz) applied early heading, 1,100 - 1,300 GDD
Quilt Excel (10 oz) applied full heading, 1,700 - 1,900 GDD

Fall seeded ryegrass in wheat stubble

Ryegrass seeded at 5-7#/acre after wheat harvest into existing stubble
Pre-harvest glyphosate application to wheat , or
glyphosate applied to wheat stubble prior to seeding ryegrass.
No broadleaf application in fall but other management for fall seeded ryegrass the same as spring seeded.

Kentucky bluegrass

Variety trial seeded at 3#/acre with 60#/acre of spring wheat on 6/7/2017
90-40-40-10s applied 10/18/2017
2pt.Curtail + 1pt. Sterling Blue applied 9/24/2017
3 oz. Tilt applied 5/27/2018

General seed harvest procedure for small research plot

Measured areas are hand cut and bagged for each individual plot.
These samples are then brought to the U of M St.Paul campus
where they are dried, threshed, cleaned and weighed.
Seed yields and other data are statistically analyzed and results summarized.

On-farm small plot research trials

All crop planting and general management are done by the grower/cooperator.
Application of treatment variables, agronomic notes and harvest by University of Minnesota personnel.
Cooperators asked to avoid applications of treatments involved in the study to the research plot area.

On-farm large plot trial research protocol

These experiments are conducted in fields with growers implementing all of the general field management.
Treatment variables are field scale and may be applied either by the grower or University personnel.
University agronomists and grower cooperators work together to insure treatment variables are properly applied.
Plant samples, crop development observations and other applicable notes
are recorded as needed throughout the growing season usually by University personnel.
At harvest, University agronomists will assist the growers in collecting quality samples and harvest data.
Experimental design usually consists of 2 or 3 treatment variables and 3 replicates/treatment.

Table 1.

Monthly and Year End Precipitation Totals*

Roseau,Mn 1967-2018.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly Total(in.)	Mean Deviation	Mean(F°) Temperature
1967	1.13	0.39	0.59	2.89	0.89	2.23	4.95	1.69	0.83	1.11	0.70	1.76	19.16	-3.28	35.8
1968	0.62	T	1.25	0.63	1.46	6.47	6.13	8.49	2.35	1.26	1.06	0.21	29.93	7.49	37.3
1969	3.07	0.11	0.05	1.27	3.31	2.29	3.70	4.28	3.29	1.91	0.30	0.73	24.31	1.87	37.0
1970	0.71	0.41	1.38	2.56	5.93	4.07	3.55	0.83	2.77	1.49	1.21	0.37	25.28	2.84	35.0
1971	0.54	0.13	0.26	1.50	2.24	2.29	3.58	0.69	3.33	2.97	0.29	0.50	18.32	-4.12	36.2
1972	0.68	0.76	0.50	0.70	1.66	5.03	1.92	1.53	4.22	1.40	0.38	0.32	19.10	-3.34	34.9
1973	0.09	0.17	1.18	0.90	2.46	2.21	4.04	2.09	5.67	1.19	0.67	0.75	21.42	-1.02	M
1974	0.88	0.87	0.16	2.72	4.12	1.56	2.56	11.00	0.42	0.66	0.15	1.40	26.47	4.03	M
1975	1.10	0.29	0.64	1.40	1.52	4.96	2.26	1.75	1.79	1.49	0.20	0.65	18.05	-4.39	M
1976	1.13	0.50	1.05	0.77	0.54	5.82	1.52	3.72	0.34	0.07	T	0.37	15.83	-6.61	36.2
1977	0.14	0.62	1.02	0.27	2.43	3.71	2.28	1.74	3.83	0.87	2.27	0.26	19.44	-3.00	37.7
1978	0.36	0.26	0.17	1.00	1.97	1.92	6.25	3.25	3.44	0.23	0.98	0.79	20.62	-1.82	35.3
1979	0.50	1.01	1.06	2.77	1.89	1.91	3.70	1.59	0.45	1.40	1.02	0.16	17.46	-4.98	32.6
1980	0.55	0.82	0.35	0.00	0.24	1.75	3.35	5.19	4.12	1.66	0.94	0.18	19.15	-3.29	36.0
1981	0.27	0.16	0.66	0.56	2.79	6.85	2.63	2.41	3.63	1.75	0.90	0.99	23.60	1.16	38.3
1982	1.30	0.45	0.74	0.24	1.38	2.00	5.53	2.71	1.92	2.91	0.46	0.57	20.21	-2.23	34.2
1983	1.31	1.26	1.17	0.53	2.76	4.03	1.62	3.34	2.91	2.26	0.66	0.10	21.95	-0.49	37.7
1984	T	0.95	T	0.72	0.72	4.46	3.78	0.99	0.37	4.32	0.10	1.02	17.43	-5.01	37.3
1985	0.12	0.33	0.06	1.07	4.35	4.62	1.08	8.72	1.60	1.04	1.68	0.38	25.05	2.61	34.4
1986	0.30	0.90	0.26	2.96	1.40	2.43	3.59	2.04	2.52	0.65	1.97	0.36	19.38	-3.06	M
1987	0.47	0.30	0.10	0.59	4.37	2.25	4.80	2.22	0.82	0.92	0.73	0.35	17.92	-4.52	M
1988	0.60	0.09	1.75	0.00	1.74	1.34	5.53	1.70	2.24	0.12	0.77	1.05	16.93	-5.51	M
1989	3.27	0.32	2.86	0.10	2.82	5.46	1.60	2.56	1.24	0.41	0.62	0.45	21.71	-0.73	M
1990	0.55	0.20	1.12	1.09	0.46	3.19	2.48	0.62	0.91	0.16	0.18	0.72	11.68	-10.76	38.2
										Mean temperature 1967-1990 =					**36.1**
1991	0.56	0.64	0.58	2.87	3.19	5.94	3.40	1.99	7.42	1.64	1.36	0.70	30.29	7.85	M
1992	0.61	0.68	0.45	2.27	1.99	2.36	2.72	4.51	2.76	0.12	1.27	0.88	20.62	-1.82	36.5
1993	0.68	0.05	0.27	1.01	1.63	5.06	5.87	4.69	0.72	0.71	0.45	0.65	21.79	-0.65	35.5
1994	0.21	0.33	0.47	0.02	0.16	2.54	3.03	3.48	3.94	1.38	2.72	0.32	18.60	-3.84	37.7
1995	0.57	0.59	1.23	0.61	2.50	2.13	4.59	3.59	1.81	1.33	1.54	1.46	21.95	-0.49	35.8
1996	0.94	0.48	0.22	1.65	4.62	1.64	7.34	1.78	1.77	1.75	2.73	1.07	25.99	3.55	M
1997	1.06	0.14	1.02	0.84	2.02	3.36	4.02	1.31	4.01	2.45	0.19	0.25	20.67	-1.77	M
1998	0.69	1.05	0.21	0.77	4.55	5.39	3.01	2.20	0.31	4.42	1.39	0.95	24.94	2.50	M
1999	0.15	0.77	0.23	1.31	4.09	6.97	3.46	1.38	3.16	0.43	0.38	0.56	22.89	0.45	40.1
2000	0.45	0.14	0.79	0.38	1.83	7.38	1.63	6.45	2.14	2.89	3.41	0.74	28.23	5.79	38.2
2001	0.21	0.52	0.46	1.89	3.27	1.76	4.74	1.40	0.72	1.76	1.50	0.56	18.79	-3.65	39.8
2002	0.19	0.10	0.45	1.44	2.79	9.94	2.96	4.47	1.62	1.02	0.30	0.54	25.82	3.38	38.1
2003	0.80	0.77	1.60	1.75	2.95	3.56	1.92	1.78	4.55	1.32	1.52	1.95	24.47	2.03	37.6
2004	2.85	0.70	2.14	2.61	8.19	2.98	2.42	5.50	2.97	2.36	0.08	1.33	34.13	11.69	36.0
2005	2.33	0.67	0.82	0.73	3.62	7.55	3.37	3.24	1.77	3.48	2.06	1.65	31.29	8.85	39.0
2006	2.52	0.95	1.01	1.23	1.97	1.00	0.94	2.18	2.42	1.54	0.17	0.56	16.49	-5.95	41.0
2007	0.44	0.56	1.25	0.95	2.75	7.75	2.92	1.37	0.92	5.14	0.39	0.86	25.30	2.86	38.0
2008	0.25	1.29	0.46	2.17	1.56	3.93	4.33	3.63	3.06	2.37	2.00	1.47	26.52	4.08	36.0
2009	1.25	1.75	4.45	1.37	3.59	3.72	1.28	3.92	2.67	1.06	0.28	1.22	26.56	4.12	36.0
2010	0.80	0.43	0.55	1.23	6.47	2.88	3.79	1.50	6.09	2.42	1.14	0.61	27.91	5.47	40.0
2011	1.15	0.20	0.23	3.14	2.63	3.87	2.38	1.63	0.89	1.34	0.19	0.07	17.72	-4.72	39.0
2012	0.59	1.06	2.06	1.39	1.48	3.32	2.74	1.42	0.18	3.64	1.22	0.24	19.10	-3.34	41.0
2013	1.34	1.21	1.05	1.40	4.69	1.70	2.14	3.77	2.65	0.84	1.43	1.85	24.07	1.63	35.0
2014	2.32	0.54	3.31	1.71	3.74	4.23	2.21	1.62	2.68	1.14	0.75	1.49	25.74	3.30	36.0
2015	1.11	0.57	0.71	0.42	5.18	4.33	6.27	4.45	1.43	2.08	1.52	3.08	31.15	8.71	41.0
2016	0.39	0.89	1.31	1.29	3.14	5.71	3.57	1.23	3.97	0.97	0.85	0.75	24.07	1.63	42.0
2017	1.44	1.55	0.59	0.47	0.90	5.55	0.83	0.99	6.22	0.97	0.94	2.71	23.16	0.72	41.2
2018	1.04	0.99	2.76	0.02	2.71	1.89	1.75	1.36	2.05	1.68	0.62	1.28	18.15	-4.29	36.6
						52 year average annual precipitation							**22.44**		
										Mean temperature 1991-2018 =					**38.1**
										50 year available mean temperature=					**37.4**

*Precipitation amounts used are from the Magnusson Research Farm-near Roseau May-October and Minnesota Climatology Working Group nearest location or Fox NDAWN for the remainder of the year.

Average precipitation the last 15 years=24.76". Average precipitation the previous 35 years=21.29"

Table 2.

2017 Kentucky Bluegrass Variety Trial-

Magnusson Research farm-F2B

2018 Data

			Seed Yield	Harvest			Heading (%)							
LINE	Company	MSP#	#/acre	Height	Lodging	Date	5/24	5/27	5/30	6/2	6/6	6/10	6/14	6/14DV
Blue Note	Mountain View seed	4052	**293**	17	1.0	10-Jul	0	0	2	8	21	53	84	80
Bolt	Mountain View seed	4053	**376**	22	1.3	10-Jul	0	2	13	46	65	78	89	90
A99-3124	MN-Rutgers	3920	**303**	19	1.0	10-Jul	0	0	0	0	4	23	53	43
a99-2950	MN-Rutgers	3898	**296**	19	1.0	10-Jul	0	0	0	3	15	48	83	75
a99-2626	MN-Rutgers	3899	**349**	18	1.0	8-Jul	0	0	0	1	9	30	65	45
Minnfine	check	4063	**821**	30	1.8	1-Jul	28	60	85	96	99	99	99	99
Park	check	4062	**478**	30	1.3	1-Jul	11	30	58	86	99	99	99	99
Dragon	check	4054	**594**	22	1.3	5-Jul	0	2	9	43	73	94	99	92
Exp#1	DLK- seed research	4064	**552**	24	1.0	5-Jul	0	2	11	43	70	96	99	99
Abbey	check	3608	**770**	20	1.0	5-Jul	0	0	1	9	33	70	95	83
		LSD @5%level	**112**	4	0.5	1	4	7	10	16	19	21	13	13
		CV(%)	16	12	29	14	63	52	39	32	27	21	10	11

Data here present mean yields of Beacon treated and not treated plots

483.2

			Seed Yield	Harvest			Heading (%)							
Line	Treatment	MSP#	#/acre	Height	Lodging	Date	5/24	5/27	5/30	6/2	6/6	6/10	6/14	6/14DV
Blue Note	No Beacon	4052	**369**	20	1.0	7/10	0	0	4	13	30	60	93	85
Blue Note	*Beacon*	*4052*	***218***	*16*	*1.0*	*7/10*	*0*	*0*	*1*	*3*	*13*	*45*	*75*	*75*
Bolt	No Beacon	4053	**374**	28	1.5	7/10	0	3	15	65	85	99	99	95
Bolt	*Beacon*	*4053*	***378***	*15*	*1.0*	*7/10*	*0*	*0*	*11*	*28*	*45*	*58*	*80*	*85*
A99-3124	No Beacon	3920	**347**	24	1.0	7/10	0	0	0	1	6	35	65	55
A99-3124	*Beacon*	*3920*	***258***	*14*	*1.0*	*7/10*	*0*	*0*	*0*	*0*	*3*	*10*	*40*	*30*
a99-2950	No Beacon	3898	**307**	22	1.0	7/10	0	0	0	3	15	50	85	80
a99-2950	*Beacon*	*3898*	***285***	*15*	*1.0*	*7/10*	*0*	*0*	*0*	*3*	*15*	*45*	*80*	*70*
a99-2626	No Beacon	3899	**374**	20	1.0	7/10	0	0	0	1	11	30	70	55
a99-2626	*Beacon*	*3899*	***325***	*16*	*1.0*	*7/5*	*0*	*0*	*0*	*1*	*8*	*30*	*60*	*35*
Minnfine	No Beacon	4063	**752**	32	2.0	7/1	30	65	90	97	99	99	99	99
Minnfine	*Beacon*	*4063*	***890***	*28*	*1.5*	*7/1*	*25*	*55*	*80*	*95*	*99*	*99*	*99*	*99*
Park	No Beacon	4062	**481**	31	1.0	7/1	15	40	65	93	99	99	99	95
Park	*Beacon*	*4062*	***476***	*28*	*1.5*	*7/1*	*8*	*20*	*50*	*80*	*99*	*99*	*99*	*90*
Dragon	No Beacon	4054	**632**	22	1.0	7/5	0	3	13	50	80	97	99	90
Dragon	*Beacon*	*4054*	***556***	*21*	*1.5*	*7/5*	*0*	*1*	*6*	*35*	*65*	*90*	*99*	*95*
exp#1	No Beacon	4064	**516**	25	1.0	7/5	0	1	8	40	65	95	99	99
exp#1	*Beacon*	*4064*	***587***	*24*	*1.0*	*7/5*	*0*	*3*	*15*	*45*	*75*	*97*	*99*	*99*
Abbey	No Beacon	3608	**765**	23	1.0	7/5	0	0	1	10	35	75	95	80
Abbey	*Beacon*	*3608*	***774***	*17*	*1.0*	*7/5*	*0*	*0*	*1*	*8*	*30*	*65*	*95*	*85*
		LSD @5% level	**171**	5	0.7	1	5	8	15	20	27	31	18	16
		CV(%)	17	10	28	1	63	42	42	29	26	22	10	10

Experimental design:Split plot with 2 reps

Beacon .4oz.+.25%NIS applied to rep 1-2 on 5/10/2018

Growth stage at treatment=Vegetative

Trial Mean Seed Yield= 483#/acre

Beacon Applied Mean Yield= 475#/acre

No Beacon Mean Yield= 492#/acre

Table 3.

2017 Intermediate Wheatgrass-Kernza Variety Trial

Magnusson Research Farm-Roseau,Mn and overall locations seed yields

2018 data

Variety	Seed Yield-#/acre		Lodging[2]	Ht.(in.)
	All locations[1]	Roseau	Roseau	Roseau
2015C4	600	728	1.6	51
20163471Selfs	598	517	1.9	52
2016C3	535	503	1.1	53
2016C4	547	561	1.5	51
2016C5	583	496	1.0	51
Lot # SFD - 12 - Thin 6 - 4	493	627	1.8	52
MN1501-Syn2	570	556	1.6	51
MN1502-Syn2	580	515	1.6	50
MN1503-Syn2	528	566	1.6	52
MN1504-Syn2	810	737	1.0	50
MN1505-Syn	680	671	1.0	49
Rush	470	483	3.1	48
All Variety Yield Mean=	583	580		

Experimental Design: RCB with 4 reps

Seeded 8/15/2017 @ 10#/acre

[1]Locations: Roseau, Lamberton, Staples, Rosemount D5, Rosemount R70

[2]Lodging-1=No lodging ;10=Flat

Table 4.

2017 Perennial Ryegrass Seed Production Variety trial

Magnusson Research Farm Roseau,Mn.

2018 Data

		Seed	Seed Yield		Harvest			Heading (%)				RCI[2]
Source	Variety	Lot	#/acre	% Mean	Date	Ht.(In)	Lodging[1]	6/11	6/14	6/18	6/22	6/12
McCarthy	MRSL-PR-15	4056	**1748**	**121**	18-Jul	21	2.5	18	43	60	100	679
McCarthy	Excellence	4059	**1672**	**116**	18-Jul	21	1.3	19	48	70	100	634
McCarthy	MRSL-PR-16	4057	**1667**	**116**	17-Jul	21	3.0	20	45	68	96	648
McCarthy	A-6D	4055	**1645**	**114**	18-Jul	21	3.3	21	53	75	100	699
McCarthy	N-6-16	4058	**1638**	**114**	17-Jul	18	1.0	23	40	63	93	698
U of M	Arctic Green	4038	**1571**	**109**	19-Jul	22	7.0	11	30	60	94	554
U of M	Green EmperorxArctic Green	4020	**1537**	**107**	18-Jul	22	4.8	13	33	55	95	583
U of M	Green Emperor	3976	**1521**	**106**	19-Jul	22	5.5	12	43	68	96	651
U of M	Green EmperorxRoyal Green	4031	**1429**	**99**	20-Jul	24	4.8	6	25	53	94	569
U of M	G.EmperorxA.Green/R.Green	4050	**1395**	**97**	22-Jul	22	5.3	9	25	50	91	607
Lebanon	Secretariat II GLSR	4061	**1393**	**97**	19-Jul	23	5.8	23	55	80	100	545
U of M	Spreader IIIxArctic Green	4051	**1359**	**94**	22-Jul	24	6.5	8	25	55	95	589
check	NK-200	3917	**1255**	**87**	26-Jul	27	3.3	1	11	25	63	496
Columbia	Premium	4060	**1251**	**87**	21-Jul	24	7.5	20	45	75	100	503
Jacklin	Accent II	4026	**1240**	**86**	20-Jul	23	6.3	15	40	75	100	564
U of M	Forageur	3984	**1116**	**77**	24-Jul	25	5.5	4	15	35	75	503
U of M	Spreader IV	4029	**1068**	**74**	23-Jul	24	4.8	6	33	60	91	539
	LSD @ 5% level		**161**	**11**	3	2	1.8	11	16	15	8	50
	CV(%)		**7**	**7**	10	5	28	59	33	18	6	6

Experimental Design: RCB with 4 reps

[1]-1=no lodging;9=flat Mean seed yield= 1441#/acre

[2]-RCI-relative chlorophyll index- higher number = more chlorophyll

Seeding Rate=6#/acre

Planted 5/18/2017 With 120#/ac Linkert spring wheat

Table 5.

2017 Perennial Ryegrass Winter Hardiness Trial

St.Paul and Roseau,Mn[1]

2018 Data

		Winter Injury[1]--St.Paul		
	Seed lot	5/15	5/28	Mean
Green EmperorxArctic Green	4031	5.3	4.9	5.1
Green Emperor	3976	7.0	7.0	7.0
Gulf-annual	3983	9.0	9.0	9.0
G.EmperorxA.Green/R.Green	4050	5.6	4.6	5.1
NK-200	3917	5.5	5.4	5.4
Accent II	4026	8.0	7.5	7.8
Forageur	4043	5.8	4.5	5.1
Arctic Green	4038	6.0	4.8	5.4
Spreader IIIxArctic Green	4030	7.0	5.5	6.3
Spreader IV	4029	6.1	5.8	5.9
LSD @ 5% level		2.2	2.4	2.2
CV(%)		23	28	24

Experimental Design: RCB with 4 reps

Roseau location Seeded 9/12/2017

St.Paul location Seeded 9/18/2017

[1]-Roseau location was entirely winter killed and no notes were taken

Table 6.

2018 Large Plot Perennial Ryegrass Sulfur Fertility Trial- Rice Farm

Magnusson Research Farm

Variety- Evolution--

												Tissue analysis 6/1/2018[4]						
	Added[1]	**Seed Yield**	Harvest	Harvest	6/4	5/25	6/4	6/12	5/25	6/4	6/12	%						ppm
Trt	Fertility	**#/acre**	Lodging	Ht(in)		RCI	RCI	RCI	Vigor	Vigor	%Heading	N	P	K	S	Ca	Mg	Fe
1	26-0-0-30S	**1660**	2	21	12	459	639	579	6.3	7.7	25	3.6	0.42	3.1	0.38	0.53	0.50	77
2	26-0-0	**1342**	1	19	9	363	528	445	3.0	4.3	8	3.4	0.40	2.6	0.14	0.48	0.42	65
3	0	**1325**	1	19	9	303	513	461	2.7	4.7	9	3.3	0.40	2.8	0.14	0.45	0.44	62
	LSD @5% level	**139**	0	2	1	82	76	72	1.8	1.5	9	NS	NS	0.4	0.07	NS	0.08	NS
	CV(%)	4	0	4	6	10	6	6	20	12	29	6	6	6	15	7	8	11

Experimental design: RCB with 3 reps

All general management and harvest operations were done by Rice Farms.

Fertilizer regime- 9/10/2017 8-40-40 5/6/2018 110-0-0 5/11/2018 AMS and Urea plot treatments

[1]-Fertilizer application of ammonium sulfate(AMS) to treatment #1 and urea to treatment #2. No added fertilizer to treament #3

Applications made by University of Minnesota with 12' Gandy drop spreader.

[1]-Conversions-

125#/acre AMS applied=(26-0-0-30s)

57#/acre urea applied=(26-0-0)

Plot size =48' x 600'

Harvest area of 32' x 505' / plot x 3 reps(9 plots total) was done by Rice Farms-7/24/2018

University of Minnesota personel was on hand at harvest with weigh wagon to record weights and collect quality samples.

0-6" Soil test- 5/9/2018=

Phosphorous -Olsen P-15ppm(very high) , Potassium -125ppm(high), sulfur 10ppm(low), organic matter- 3%

Table 7.

2017-18 Perennial Ryegrass Fertility Trial

Magnusson Research Farm-Roseau,Mn

2018 Data

	Fertilizer Rate:	Application[1]	Seed Yield[1]		Harvest			RCI[3]			Visual Color Rating		
Trt#	N level	Timing	% mean	#/acre	Date	Ht(in.)	Lodging[2]	5/25	6/4	7/8	5/1	5/25	6/4
1	0	None	**21**	**338**	19-Jul	15	1.0	117	180	149	3.0	1.0	2.0
2	140+0+0	Fall+Spring	**101**	**1647**	24-Jul	22	5.5	239	400	327	6.0	4.5	6.0
3	140+0+0	Fall+Spring	**107**	**1738**	23-Jul	23	6.0	293	468	290	7.0	6.0	6.3
4	140+0+0	Spring	**94**	**1537**	24-Jul	23	4.3	182	393	354	2.5	3.5	5.0
5	100+0+0	Fall+Spring	**90**	**1473**	20-Jul	22	2.5	205	436	266	5.5	3.5	5.8
6	180+0+0	Fall+Spring	**107**	**1751**	24-Jul	22	7.3	221	397	339	5.5	4.0	5.5
7	140+0+0+20s	FallAMS+Spring	**101**	**1649**	23-Jul	22	6.5	342	527	263	6.0	7.5	8.3
8	140+0+0	Fall+Spring+Liquid	**105**	**1718**	22-Jul	23	5.0	243	428	292	6.5	4.0	5.5
9	140+0+0	Fall+Spring+Liquid	**101**	**1653**	23-Jul	23	5.3	213	425	290	6.0	4.0	6.8
10	100+0+0	Fall+Spring+Liquid	**93**	**1515**	22-Jul	23	5.0	229	429	321	5.5	4.0	5.5
11[a]	14-0-0	Spring AMS	**40**	**659**	19-Jul	17	1.0						
		LSD @5%level	**11**	**190**	2	2	1.1	55	67	47	1.4	1.7	1.2
		CV(%)	8	8	5	5	16	16	11	11	18	28	14

Experimental Design:RCB w/4reps Variety=Arctic Green

Mean yield(not including 0# N)= 1631#/ac 8-40-40 added to all plots 9/14/2017

[1]-Seed Yield- Clean seed yield of each treatment in LBS/Acre and % of trial mean(not including Trt 1 & 11))

[2]-Lodging-1=upright;9=flat

[3]-RCI-Relative Chlorophyll Index-higher value=more chlorophyll

Best management practices used on all plots aside from fertility variables

10/17/2017 Soil test results

5/5/2016	Depth	Olsen P	NH4O-K	% OM	PH	NO3-N
	0-6"	13ppm	108ppm	2.6	7.9	3.5ppm
	6-24"					1.9ppm

Trt#	Total #N Season	Treatment applications and timing
1	0	No added N
2	140	30-0-0 10/26/17 + 110-0-0 5/12/2018
3	140	30-0-0 10/26/17 + 110-40-0 5/12/2018
4	140	140-0-0 5/12/2018
5	140	30-0-0 10/26/17 + 70-0-0 5/12/2018
6	180	30-0-0 10/26/17 + 150-0-0 5/12/2018
7	140	30-0-0-20s 10/26/17 + 110-0-0 5/12/18
8	140	30-0-0 10/26/17 + 80-0-0 5/12/2018 + 7gal--28%N 5/12/2018(Streamer nozzels)
9	**140**	30-0-0 10/26/17 + 80-0-0 5/12/2018 + 7gal--28%N 5/12/2018(flat fan nozzels)
10	**100**	30-0-0 10/26/17 + 40-0-0 5/12/2018 + 7gal--28%N 5/12/2018(flat fan nozzels)
11[a]	**14**	14-0-0-18s(20gal Npak-AMS) 5/12/2018 1 plot treatment only on outside of plot area

Table 7a.

2011-18 Perennial Ryegrass Fertility Trial Seed Yield Summaries

Magnusson Research Farm-Roseau,Mn

Trt. #	Total added Fertilizer	Nitrogen Timing	**Overall[3] Mean**	Seed Yield as % of Mean							
				2018	2017	2016	2015	2014	2013	2012	2011
1	0	0	**30**	**21**	45	38	29	27	28	21	36
2	100+0+0	Split[1]	**100**	**90**	104	90	----	92	96	112	108
3	140+0+0	Split[1]	**109**	**101**	99	110	99	104	104	118	118
4	140+40+0	Split[1]+(0-40-0spring)	**114**	**107**	106	109	127	120	----	----	----
5	140+0+0+20s	Split[2]	**105**	**101**	102	----	----	110	99	----	----
6	140+0+0	Split[1]+(90spring+20liq)	**104**	**101**	99	----	----	106	109	----	----
7	180+0+0	Split[1]	**115**	**107**	92	111	----	122	111	----	----
		LSD @5% level		11	13	12	20	11	16	11	12
		CV(%)		8	9	9	16	8			

Experimental Design:RCB with 4 reps Variety=Arctic Green

2018 Trial mean(excluding 0-N fertilizer)=1631 #/ac.

[1]-Split-30-40-40 applied fall and remainder in spring

[2]-Split-30-0-0-20s(77#AMS/acre)+110-0-0 in early May

[3]-Overall Means- consideration should be given to years the treatments were made when making comparisons.

Trt. #	**Explanation of fertility treatments**
1	No fertilizer added
2	30-40-40 applied Sept-Oct. / 70-0-0 applied early May
3	30-40-40 applied Sept.-Oct. / 110-0-0 applied early May (Standard)
4	30-40-40 applied Sept-Oct. / 110-40-0 applied early May
5	30-40-40-20s(77#AMS) Sept-Oct
6	30-40-40 applied Sept-Oct. / 90-0-0 applied May / 7 gal. 28%UAN applied mid-June
7	30-40-40 applied Sept-Oct./ 150-0-0 applied early May

Table 8.

2017-18 Pre-Emergent Herbicide Applications to Perennial Ryegrass

Magnusson Research Farm

		Application		Seed Yield		Harvest		Herbicide[2]
Trt#	Treatments:	Rate	Timing	#/acre	% of check	Ht.(in.)	Lodging[1]	Injury
1	No treatment			**1382**	**100**	21	4.5	1.0
2	Callisto	6oz.	10/25/2017	**1308**	**95**	22	4.3	1.8
3	Callisto	3oz *	10/25/2017	**1286**	**93**	20	3.3	1.8
4	Callisto	3oz *	5/4/2018	**1348**	**98**	21	3.0	1.5
5	Nortron	2pt+2pt	10/25+5/4	**1291**	**93**	21	4.3	1.0
6	Outlook+Nortron	1 pt+2pt	10/25+5/4	**1246**	**90**	20	2.0	4.3
7	Outlook	1 pt	10/25/2017	**1108**	**80**	20	2.0	3.8
8	Zidua SC	2 oz	5/4/2018	**1079**	**78**	20	1.3	6.0
9	Axiom DF	6oz.	10/25/2017	**1228**	**89**	21	2.0	3.3
10	Axiom DF	6oz.	5/4/2018	**1108**	**80**	20	1.3	5.3
11	Diuron 4L	2pt	10/25/2017	**1135**	**82**	22	2.0	2.0
		LSD @5% level		**184**	**12**	2	1.5	1.0
		CV(%)		**10**	**10**	6	37	25

Experimental Design: RCB with 4 reps
Variety-Arctic Green
harvest date=7/24/2018
*-1%MSO+2.5% - 28%UAN added

[1]-1=No lodging; 9=flat

[2]-Herbicide injury at harvest -visual rating 1=none ; 9=dead
Visual Injury criteria-vigor reduction,stand reduction,and maturity delay

Applications made with CO2 bike sprayer @12GPA and 26psi

Fall applied 10/25/2017
4:15pm 50F overcast SE 5mph 53%RH
4" soil temp 51F

Spring applied 5/4/18 sunny wind S 2-5mph -60F
GS- first greenup

Trade Name	Common name and active ingredient formulation
Callisto	mesotrione 4#/gal
Nortron	ethofumesate 4#/gal
Outlook	dimethenamid 6#/gal
Zidua	pyroxasulfon 4.17#/gal
Axiom DF	flufenacet54.4%+metribuzin13.6%
Diuron 4L	diuron 4#/gal

Table 9.

2018 Perennial Ryegrass Fungicide Trial

Roseau and Lake of the Woods Locations*

			Seed Yield (#/acre			Harvest Ht(In.)			Lodging at Harvest		
TRT #	Product	Rate/ac.	**MagPlot**	**Pieper**	**Mean**	MagPlot	Pieper	Mean	MagPlot	Pieper	Mean
1	Aproach2.08+PropiMax	6 oz.+4oz.	**1404**	**1226**	**1315**	20	27	23	3.3	7.8	5.5
2	Aproach2.08+PropiMax	9 oz.+4oz.	**1424**	**1469**	**1446**	20	28	24	3.3	6.3	4.8
3	Quilt Xcel 2.2 SE	14oz	**1364**	**1433**	**1398**	20	28	24	2.8	7.5	5.1
4	Prosaro	8 oz	**1417**	**1542**	**1480**	20	28	24	3.3	7.8	5.5
5	Aproach2.08	9 oz.	**1513**	**1353**	**1433**	20	27	23	2.8	6.3	4.5
6	Quilt Xcel 2.2 SE+Warrior	14oz+2oz	**1404**	**1297**	**1351**	21	29	25	2.3	7.5	4.9
7	PropiMax	4oz.	**1366**	**1395**	**1381**	19	28	24	3.0	7.3	5.1
8	Folicur	5 oz.	**1415**	**1279**	**1347**	21	28	24	2.5	6.5	4.5
9	Priaxor	6oz.	**1440**	**1420**	**1430**	19	27	23	3.5	7.3	5.4
10	No treatment		**1370**	**1212**	**1291**	21	27	24	2.8	6.5	4.6
	LSD @5% level		**146**	**205**	**136**	NS	NS	NS	NS	NS	NS
	CV(%)		**7**	**10**	**6**	6	5	4	28	18	17

Experimental Design: RCB with 4 reps

.25%NIS added to all treatments

*Locations-

Lake of the Woods - Dan Pieper farm
Variety=Exacta II GLSR
Harvest date 7/19/2018
Application 6/27/2017 8:00pm
gs= fully headed. Early bloom
65F wnw 2-6mph
9' backpack sprayer @26psi and 12gpa

Roseau-Magnusson Research farm
Variety=Arctic Green
Harvest date= 7/18/2018
Applications made 7/2/2018 7:00pm with 10' bike sprayer-dave
GS= fully headed mid bloom

Trade Name	Common name	AI #/gal Formulation
Aproach 2.08	picoxystrobin	2.08
PropiMax	propiconazol	3.6
Quilt Xcel 2.2 SE	azoxystrobin+propiconazole	1.02+1.18
Prosaro 421SC	prothioconozole+tebuconazol	1.76+1.76
Folicur	tebuconazole	3.6
Priaxor	fluxapyroxad+pyraclostrobin	1.39+2.78
Warrior II	lambda-cyhalothrin	2.08

Table 9a.

2016-18 Ryegrass Fungicide Yield Summary

2 Locations Per Year -Roseau and Lake of the Woods

Product	Adjuvunt	Rate/ac.	% of Mean			
			2016-18*	2018	2017	2016
No treatment			**88**	93	89	83
Quilt Xcel 2.2 SE	1%COC	14 oz.	**103**	101	103	106
Quilt Xcel 2.2 SE+Warrior	1%COC	14oz+2oz	**102**	97	106	----
Absolute 4.36 SC	1%COC	7.5 oz.	**99**	----	99	99
Aproach2.08	.25%NIS	9 oz.	**100**	103	99	99
Aproach2.08+Tilt	.25%NIS	6 oz.+4oz.	**100**	95	104	----
Aproach2.08+Tilt	.25%NIS	9 oz.+4oz.	**103**	104	102	----
Trivapro SE	1%COC	13.7 oz.	----	----	----	102
Trivapro SE	1%COC	17 oz.	----	----	----	104
Tilt(PropiMax)	.25%NIS	4oz.	**100**	100	99	----
Folicur	.25%NIS	5 oz.	**97**	97	96	99
Prosaro SC	.25%NIS	6.5 oz.	**106**	107	----	105
Priaxor	.25%NIS	6oz.	**105**	103	104	106
		LSD @5% level		9	8	12
		CV(%)		7	5	8

2018 Mean Yield= 1387 #/acre

2017 Mean Yield= 1675 #/acre

2016 Mean Yield= 1301 #/acre

* Mean of available treatments for 2-3 years.

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Table 10.

2018 Effects of Spring Stubble Clipping on Ryegrass Seed Production

Rice Farms-Roseau,Mn

Variety-Evolution

Clip Treatment[1]	Clip date	**Seed Yield #/acre**	Harvest Ht.(In.)	Ht.(In.) 5/25		Lodging[2]
				ryegrass	wheat	
Early	5/4/2018	**1611**	19	5.7	4	1
Late	5/25/2018	**1394**	18	5.0	5	1
No Clip		**1430**	19	7.5	8	1
LSD @5% level		**63**	NS	0.8	2	0
CV(%)		**2**	6	5	13	0

[1]-Clip treatments mowed and raked off

Early=5/4 (200GDD) 4" cutting height

Late=5/25(600GDD) 6" cutting height

[2]-Lodging-1=no lodging

If trial is repeated, eliminate late clip add early mow and leave residue.

Table 11.

2018 Growth Regulator Applications to Perennial Ryegrass

Magnusson Research Farm-F4 Roseau,Mn

2018 Data and seed yields from 2017 trial

TRT#	PGR treat	Rate/acre	Additive	2 Yr. Ave **% of mean**	Seed Yield #/acre **2018**	2017	Lodging[1] at harvest	Ht.(In.) at harvest
1	No treatment			**84**	**921**	1484	8.5	27
2	Palisade EC	.75pt	.25%NIS	**98**	**1086**	1724	6.0	24
3	Palisade EC	1.5pt	.25%NIS	**101**	**1148**	1735	4.5	20
4	Palisade+Apogee	.75+4oz	.25%NIS/.25%+3gal	**----**	**1081**	----	5.0	21
5	Palisade EC	1.5pt	.25%NIS+3gal.AMS	**----**	**1159**	----	3.5	20
6	Apogee	4oz.	.25%NIS+3gal.AMS	**----**	**1293**	----	4.5	21
7	Apogee	8oz.	.25%NIS+3gal.AMS	**110**	**1217**	1871	3.0	21
8	Apogee	8oz.	.25%NIS+3gal. UAN	**102**	**1046**	1873	3.3	20
9	Apogee	8oz.	.25%NIS+2.5%AMS	**104**	**1280**	1700	4.8	19
		LSD @5% level			**188**	182	1.8	2
		CV(%)			**11**	7	25	7

Experimental Design: RCB with 4 reps Harvested 7-24-2018

Palisade in treatment 4=Applied 6/7 mid- boot stage 70F wind sse 5 - 12"ht

6/12/18 5:30pm late boot -early heading 68F WSW 4-6mph -14"ht

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Table 12.

2018 Late Growth Regulator Applications to Perennial Ryegrass*

Magnusson Research Farm-F2B Roseau,Mn

TRT#	Apogee Rate/acre	Quilt Excel Rate/acre	adjuvunt	**Seed Yield #/acre**	Lodging[1] at harvest	Ht.(In.) at harvest
1	3oz.	12oz.	.25%NIS+2.5%AMS	**1097**	1.8	20
2	5oz.	12oz.	.25%NIS+2.5%AMS	**1204**	2.0	19
3	8oz.	12oz.	.25%NIS+2.5%AMS	**1190**	1.5	19
4	5oz.	None	.25%NIS+2.5%AMS	**1179**	1.5	21
5	None	12oz.	.25%NIS	**1208**	1.8	19
6	None	None	None	**1103**	2.0	20
		LSD @5% level		**NS**	NS	NS
		CV(%)		**11**	38	7

Experimental Design: RCB with 4 reps Harvest date- 7-16-2018

All applications made 7/2/2018 7:00pm with bike sprayer. GS- Pollen Shedding

*This area on west side of Magnusson Research Farm is a sandy loam soil and may have had more drought stress than other fields.

[1]-Lodging-1=None ;9=Flat

Trade Name	Common name	AI #/gal Formulation
Palisade EC	trinexapac-ethyl	1.0
Apogee	prohexadione	27.5% dry
Quilt Excel	azoxystrobin+propiconazole	1.02+1.18
N-PAK AMS	ammonium sulfate	3 gallons(10# dry AMS-2.1#N)/Acre
N-PAK AMS	ammonium sulfate	2.5%=2.5 gallons (8.3#dry)/100 gallons
N-PAK 28%N	28%urea ammonium nitrate	3 gallons=(3#N)
NIS	Preference	.25%NIS=2pt/100 gallons-90%non ionic surfactant

Table 13.

2018 Growth Regulator x Fertility Houndog Tall fescue

Magnusson Research Farm-Roseau,Mn

Fertility[1]	Growth regulator[2]	**Seed Yield #/acre**	Ht.(In.)	Lodging[3]
High Fertility	Apogee	**1872**	37	1.3
High Fertility	No PGR	**1756**	39	7.7
Low Fertility	Apogee	**1231**	11	1.0
Low Fertility	No PGR	**1062**	12	1.0
	LSD @ 5% level	**429**	6	1.0
	CV(%)	**14**	8	5

Experimental design: RCB with 3 reps

2018 Tall fescue post emergent liquid fertilizer applications

Fertility[1]		Post Liquid application	**Seed yield #/acre**
Low Fertility	No PGR	10GPA-AMS	**1085**
Low Fertility	No PGR	10GPA-28%N	**1224**
Low Fertility	No PGR	None added	**1012**
	LSD @ 5% level		**175(NS)**
	CV(%)		**25**

Experimental design: RCB with 2 reps

[1]Fertility=

High fertility 55-40-40-10s 9/14/17 + 140-40-40-20s 5/10/2018

Low fertility 55-40-40-10s 9/14/2017 + 70-20-20-10s 5/10/2018

Liquid applications made with CO2 bicycle sprayer @ 28psi with flat fan nozzels and 12gpa(10 gpa AMS or 28%UAN)

[2]Growth Regulators- Apogee=8oz.+2.5%AMS+.25%NIS

[3]Lodging- 1-no lodging; 9=flat

Table 14.

2016-19 MN-HD Hard Fescue Herbicide Screen[1]

Magnusson Research farm-Roseau,Mn.

2016-18 seed yields and other 2018 data

		Seed Yield-#/acre				Vigor[2]	Ht (in.)		Heading (%)
Treatment	Rate/Adjuvunt	**2016**	**2017**	**2018**	**3Yr Ave.**	6/25	Harvest	6/14	6/14
1-Section 2	12oz+1%COC	**35**	**605**	**0**	**213**	1.0	5	5	0
2-Fusilade [4]	10oz.+1%COC	**1789**	**851**	**762**	**1134**	7.0	25	20	70
3-Callisto	3oz.+1%COC+2.5%-28%N	**1552**	**801**	**454**	**936**	7.0	21	18	57
4-Clarity	.75pt	**1629**	**584**	**537**	**917**	7.0	22	19	63
5-2,4-D amine	.75pt	**1451**	**813**	**682**	**982**	6.3	23	20	63
6-2,4-D+Clarity	.75pt+.75pt.	**1341**	**863**	**531**	**912**	6.3	23	19	53
7-UTC		**1439**	**946**	**792**	**1059**	7.0	23	19	70
	LSD @ 5% level	**393**	**307**	**257**	**138**	1.1	3	2	17
	CV(%)	**16**	**22**	**26**	**9**	10	7	5	18

Experimental Design:RCB with 3 reps

[1]-2016 and 2017 were herbicide applications to the same plot over 2 years.

2018 Seed yield and other data are from a new planting in 2017, 2018 applications, and will be repeated in 2019.

[2]Vigor-1=least;9=best vigor.

General applications to all plots -- 3/4pt. 2,4-D + 3/4pt. Clarity applied 9/15/2015 ,9/25/2016 and 9/25/2017

Trade name	common name	AI/gallon
Callisto	mesotrione	4#/gal
Section 2	clethodym	2#/gal
Fusilade DX	fluaxifop	2#/gal
Clarity	Dicamba	4#/gal
2,4-D Amine	2,4-D	4#/gal

Applications made 5/21/2018 GS= mid-boot no heading 4" tall

CO2 bike sprayer @ 27psi wind ssw 3-6mph 6pm

Harvested 7/5/2018 1M2/plot

Table 15.

2017 Kernza Intermediate Wheatgrass Planting Date Trial*

Magnusson Research farm-F4

2018 Data

Planting regime[1]	Yield[2] #/acre	Plants[3] 10/15/17	Harvest Ht.(in.)	Harvest Date
Fall - fallow plant	566	6.7	50	19-Aug
Fall - wheat stubble plant	339	5.2	46	19-Aug
Spring - with wheat	678	5.5	57	10-Aug
LSD @5% level	150	NS	1	NS
CV(%)	12	31	1	43

Experimental Design: RCB with 3 reps

Plot size= 20'x 180'

*-Kernza variety= C4-2016Rosemount

[1]-Spring planting with Linkert spring wheat @120#/acre 5/19/2017.
Fall planting into wheat stubble-8/25/2017
Fall planting into fallow ground -9/2/2017
Seeding Rate=10#/acre on all treatments

[2]-Grain yield in #/acre. Visually estimated 80% hulled seed and 10% ergot

[3]-Live plant counts/ft.2

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Table 16.

2017-18 Kernza Planting Date Trial

Magnusson Research Farm

2018 Data

Planting Date	Seed yield (#/acre)	Dry Biomass (kg/ha)	Height (cm)
	Roseau, MN 2017-18		
15 Aug. 2017	640 d	8025 c	55 c
30 Aug. 2017	416 cd	5277 c	56 c
15 Sept. 2017	347 c	4457 c	37 abc
1 Oct. 2017	85 b	1448 b	46 b
15 Oct. 2017	52 ab	768 ab	47 bc
2-May-18	1 a	1064 b	28 ab
1-Jun-18	0 a	359 a	17 a

Table 1: Effect of planting date on IWG seed and biomass yields at grain maturity, and height.

Letters signify differences between treatments within year and location using a least -squares means procedure and $\alpha = 0.05$.

Table 17.

2017-18 Sulfur Applications to Ryegrass,Fine Fescue, and Kernza

Magnusson Research Farm-F2B --Roseau,Mn

2018 Data--Arctic Green -Perennial Ryegrass

	Seed							Tissue samples taken 7/10/2018									
Added[1]	Yield	Ht(in.)	Lodging	Color	RCI	RCI	RCI	%						PPM			
Sulfur	#/acre	Harvest	harvest	5/25/18	5/25/18	6/12/18	7/8/18	N	P	K	S	Ca	Mg	Zn	Fe	Mn	B
0	616	21	1.5	5.0	192	343	216	1.2	0.23	1.30	0.15	0.25	0.34	16	36	20	5
67#AMS	905	22	3.7	4.5	202	318	259	1.5	0.22	1.25	0.17	0.23	0.35	13	37	25	5
125#AMS	728	23	3	6.0	264	379	195	1.2	0.21	1.20	0.15	0.22	0.33	13	33	22	4.5
LSD @5% level	211	2	NS	NS	NS	NS	50	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	16	15	19	19	30	10	13	10	11	11	2	7	9	20	28	13	22

2018 Data--Kernza-Intermediate wheatgrass

	Seed							Tissue samples taken 7/10/2018				
Added	Yield	Harvest	Lodging	Color	RCI	RCI	RCI	%				
Sulfur	#/acre	Ht(in.)	harvest	5/25/18	5/25/18	6/12/18	7/8/18	N	P	K	S	Ca
0	641	52	1	4.0	287	264	279	2.4	0.18	1.4	0.18	0.53
125#AMS	852	53	1	4.0	275	292	263	2.4	0.18	1.3	0.20	0.60
LSD @5% level	NS	1	0	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	13	14	0	29	22	12	3	9	0	4	15	22

Kernza - 75% hulled and 15% ergot

2018 Data--MN-HD1-Hard fescue

	Seed[1]				
Added	Yield	Harvest	Lodging	Color	RCI
Sulfur	#/acre	Ht(in.)	harvest	5/25/18	5/25/18
0	985	25	1	6.5	418
125#AMS	1044	25	1	7.5	432
LSD @5% level	NS	NS	0	NS	NS
CV(%)	18	5	0	20	16

Experimental design; RCB w/4 replications

Establishment and general management:

Ryegrass @ 6#/acre and Kernza@ 10#/acre were planted with spring wheat on 6/2/2017.

MN-HD1 hard fescue @6#/acre was planted on 6/2/2017 with no cover

Wheat was removed at harvest in August.

40-0-0 was applied to all plots on 10/18/2018

AMS(ammonium sulfate) and urea (80#N/ac for ryegrass and 40#N/ac for hard fescue and kernza)

was applied by hand on 5/7/2018. An additional 40-0-0 was applied to kernza and perennial ryegrass on 6/1/2018.

Soil test 5/5/2018-prior to spring fertilizer

Olsen P --3PPM, K 87PPM, OM 3.3%, PH 8.4, SO4-S 11PPM

Harvest dates- MN-HD- 6/28/2018, Perennial ryegrass 7/19/2018, Kernza 8/10/2018

Table 18.

2018 Potential Cover Crop Options

Magnusson Research Farm-Roseau,Mn

Trt#	Seeding PLS/ft.2 plants/ft	Seeding Rate (#/ac.)		Top growth Tons/acre dry matter	%Dry Matter	Canopy Ht.(In.)
1	8	100	Oats	0.92	21	20
2	8	110	Rymin rye	1.40	17	13
3	12	20	Gulf annual ryegrass	0.89	14	15
4	6	10	LL canola	2.30	12	18
5	4	100	winter peas	0.37	11	9
6	12	20	Crimson clover	0.25	12	4
7	12	25	Arctic Green perennial ryegrass	0.40	14	6
8	4	10	Turnip, purple top	2.08	12	15
9	8	15	Rivard mix	1.42	12	13
10	4	10	Radish-daikon	1.51	10	12
10a			Radish-daikon-(Root only)	1.52	12	na
			LSD @5%level	0.22	4	2
			CV(%)	9	14	9

Planted 8/9/2018

Wheat border=Linkert

Mix border=Rivard Mix(Grafstrom mix) 10# acre with Hege drill

Single row plots into fallow ground

15' rows--on 2' centers(except borders 6' hege planting

Rivard seeding mix

40% Austrian Winter pea

20%Rehab 94 flax

10% Dwarf Essex Rape

10% Jack hammer radish

10% common vetch

10% purple top turnips

Table 19.

2018 Soybean Sulfur Applications

Rice farms-NW of Roseau,Mn

2018 Data + 2017 Yield Data

Method of application	Fertilizer App[2]	Yield Bu./acre[1] 2yr.Mean	2018	2017	dry matter basis Oil	Protein	6/26/2018 plants/ft2	RCI[4] 8-Jul	27-Jul	Trifoliate tissue samples taken at early bloom 7/8/2018 — % N	p	k	S	ca	mg	ppm zn	fe	b
None	0	**50.9**	**55.0**	**46.7**	18.7	36.4	4.5	351	352	5.3	0.41	1.8	0.25	0.84	0.47	22	97	37
Broadcast	67#AMS/ac	**49.1**	**55.4**	**42.8**	18.9	35.6	4.6	347	347	5.1	0.43	2.1	0.27	0.96	0.54	23	103	39
In furrow	67#AMS/ac	**49.6**	**59.8**	**39.4**	19.1	35.9	3.8	353	353	5.3	0.45	2.1	0.27	0.94	0.51	24	101	40
Broadcast	125#AMS/ac	**46.5**	**54.8**	**38.2**	19.1	35.6	3.9	345	345	5.2	0.46	2.1	0.3	1	0.58	24	108	43
In furrow	125#AMS/ac	**48.8**	**59.5**	**38.0**	19	35.9	3.1	311	311	5.1	0.43	2	0.27	0.95	0.55	22	96	37
	LSD @5%level	**NS**	**NS**	**5**	1.2	1	0.9	NS	40	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CV(%)	**8**	**12**	**8**	0.3	0.6	14	9	12	4	13	10	9	9	9	10	12	7

Experimental Design:RCB with 4 reps

Variety= ASGROW AG005X8 + Apron Maxx @ 7oz/unit and Dyna Start PBC @.85oz/unit

Planting date:5-31-2018 Plot size= 6' x 15'

Seeding rate= 1.4 units/acre

SO4-S test - prior to planting 5/12/18 =9ppm --0-6"

Organic matter= 4.5%

No soil test obtained after harvest

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2018 Soybean Sulfur Applications

Magnusson Research Farm- NW of Roseau,Mn

Method of application	Fertilizer App[2]	Yield Bu./acre[1]	RCI[4] 8-Jul	Harvest Ht(in)	9/25/2018 plants/ft2	Soil test SO4-S[3]
None	0	73.0	465	25.8	4.9	14.5
Broadcast	67#AMS/ac	73.0	529	26.0	4.3	NA
In furrow	67#AMS/ac	77.8	539	26.3	4.5	NA
Broadcast+In furrow	125+125/ac	73.0	523	26.5	3.2	15.0
		NS	NS	NS	1.2	NS
		7	18	3	18	6

Experimental Design:RCB with 4 reps

Variety= ASGROW AG005X8 + Apron Maxx @ 7oz/unit and Dyna Start PBC @.85oz/unit

Planting date:5-15-2018 Plot size= 6' x 15'

Seeding rate= 1.4 units/acre

SO4-S test - prior to planting 5/12/18 =11ppm -0-6"

Organic matter= 3.0%

[1]Yield- yields corrected to 13% moisture

[2]Fertilizer App= 67#/acre ammonium sulfate(AMS)=15#/acre sulfur

125#/acre ammonium sulfate(AMS)= 30#/acre sulfur

125+125= 125#AMS applied prior to plant AND down the tube at seeding

[3]Soil test SO4-S- Soil sample taken 9/19/18 after harvest 0-6" depth only on the untreated and high application rate

[4]RCI Relative chlorophyll index, higher number equals more chlorophyll

Small plots planted with Hege plot seeder with double disk openers in 10-6" rows

Table 20.

2018 Large Plot Soybean Sulfur Fertility Trial

Magnusson Research Farm

2018 Data and 2017 Yield Data

				9/19/18						Tissue samples taken 7/8/2018									
Fertilizer*	Yield Bu./acre[1]			Soil test		Dry matter basis			Harvest	%						ppm			
Treatment	2yr.Mean	2018	2017	SO4-S	Stand[2]	Oil	Protein	Test wt.	Ht(in.)	N	p	k	S	ca	mg	zn	fe	mn	b
1-Urea	46.4	61.4	31.3	10.0	4.8	18.7	35.7	57.5	29	6.0	0.54	2.2	0.33	1.14	0.78	29	165	136	50
2-AMS	50.4	61.3	39.4	9.5	5.0	18.9	35.6	57.3	28	6.1	0.52	2.0	0.34	1.13	0.77	29	160	131	49
LSD @5%	NS	NS	6.4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	5	3	5	2	1	3	4	0.3	3.2	2	3	6	4	10	12	4	11	16	7

Experimental Design:RCB with 4 reps

Planting date: 5-17-2018 Plot size= 24' x 200'

Fertilizer applications 5/11/2018 and tilled in 5/14/18--

Soybeans seeded 5/17/2018 Asgrow--AG005X8-- Soybeans @1.4 units/acre

*57#Urea (26-0-0) applied to treatment 1 ; 125#/acre ammonium sulfate(AMS/26-0-0-30S) applied to treatment to prior to final seedbed prep

[1] Yields- Corrected to 13% moisture

[2]Stand- Plants/ft.2 at harvest

Soil test --SO4-S test - prior to planting 5/12/18 =9ppm --0-6"

Organic matter= 3.4%

Table 21.

2018 Spring Wheat Sulfur Fertility Trial

Magnusson Research Farm-Roseau,Mn

2018 Data and 2017 Yield Data

Fertility	Yield Bu./acre			Protein	Test Wt.	Stand		Harvest	RCI[3]		Color[4]	Sulfur[5]
Treatment[1]	2yr.Mean	2018	2017	%	Bu.	5/29	7/8	Ht(In.)	6/12	7/8	7/27	Soil-SO4
1-0	**77**	**61**	**93**	13.6	61.9	20.5	21.9	30	341	459	8.3	11.0
2-15B	**79**	**66**	**91**	14.2	62.1	20.6	24.1	30	348	509	8.8	NA
3-15IF	**82**	**70**	**93**	14.2	62.2	20.0	21.5	30	348	521	8.8	NA
4-30B	**82**	**69**	**94**	14.4	62.1	21.9	20.0	29	331	535	8.8	11.5
5-30IF	**81**	**71**	**91**	14.7	62.5	19.4	21.1	31	303	522	8.0	11.0
LSD @5% level	**5**	**10**	**NS**	0.8	0.3	NS	3	NS	43	NS	NS	
CV(%)	**5**	**10**	**3**	4	1	14	9	4	8	11	6	

Fertility		Plant Tissue Samples taken 7/10/2018				
Treatment[1]	Sulfur	N	P	K	Ca	Zn
1-0	**0.29**	3.7	0.26	1.6	0.43	16.5
2-15B	**0.34**	4.2	0.29	1.7	0.48	18.5
3-15IF	**0.38**	4.3	0.31	1.7	0.50	21
4-30B	**0.34**	4.2	0.28	1.5	0.46	17.5
5-30IF	**0.37**	4.4	0.29	1.6	0.48	19.5
LSD @5% level	**0.09**	0.3	0.03	NS	NS	3.8
CV(%)	9	3	4	8	10	7

Experimental Design: RCB w/4 reps

Planted 5/21/2018 harvested 8/12/18

Spring Wheat Variety- Linkert-- Seeding Rate=120#/acre

Soil test prior to fertilizer application 5/12/2018 0-6" S- SO4 15ppm ; PH 8.2 ; %OM 3.7 ;

Nitrate 14#/ac Olson P= 5ppm K=85ppm OM 3.7%

9-50-50 applied to all plots 5/10/2018. 140#/acre total Nitrogen broadcast on all plots

[1]Fertility Treatment

1-0 No added sulfur

2-15B 67#/acre AMS broadcast prior to final seedbed prep

3-15IF 67#/acre AMS source applied down the tube with seed at planting

4-30B 125#/acre AMS broadcast prior to final seedbed prep

5-30IF 125#/acre AMS applied down the tube with seed at planting

[2]Yield- Bushels/acre corrected to 12% moisture

[3]RCI- Relative Chlorophyll Index- higher number= more chlorophyll

6/12=2:45pm full sun

7/8=3:00pm ptly cldy full flag leaf extended

[4]Color-1-light green;9=dark green

[5]Soil test Sulfur sampled 0-6" after harvest-9/10/2018