

PROGRESS REPORT ON GRASS SEED PRODUCTION RESEARCH

prepared by

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This summary and previous annual research summaries are on the Web at:

http://www.mnturfseed.org/html/progress_reports.html

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Standard Management Practices for University of Minnesota Perennial Ryegrass 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 (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 (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.

General ryegrass 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 will 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 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 or local agronomists will assist the growers in collecting quality samples and recording 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 1967-2017.

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	-3.36	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	7.41	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	1.79	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	2.76	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	-4.20	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	-3.42	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	-1.09	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	3.96	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	-4.46	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	-6.68	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	-3.07	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	-1.89	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	-5.05	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	-3.36	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	1.09	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	-2.30	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	-0.56	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	-5.08	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	2.54	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	-3.13	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	-4.59	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	-5.58	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	-0.80	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	-10.83	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	7.78	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	-1.89	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	-0.72	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	-3.91	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	-0.56	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	3.48	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	-1.84	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	2.43	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	0.38	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	5.72	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	-3.72	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	3.31	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	1.96	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	11.62	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	8.78	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	-6.02	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	2.79	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	4.01	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	4.05	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	5.40	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	-4.79	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	-3.41	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	1.56	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	3.23	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	8.64	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	1.56	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	0.65	41.2
50 year average annual precipitation															
22.52															
Mean temperature 1991-2016 =															
38.3															
50 year mean temperature=															
37.4															

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

Average precipitation the last 15 years=25.36". Average precipitation the previous 35 years=21.29"

Table 2.

2016 Perennial ryegrass Seed Production Variety trial
Magnusson Research Farm-Roseau,Mn

Source	Variety	seed lot	Seed Yield		% stand*	Harvest Date	% Heading						Ht.(In)	Lodging	RCI	RCI	Color
			#/acre	% Mean			6/6	6/10	6/13	6/18	6/24	6/30					
U of M	Spreader IIIxArctic Green	4030	1437	110.8	83	30-Jul	0	3	15	50	95	99	23	2.5	447	624	5.0
U of M	Arctic Green	4038	1464	112.9	80	31-Jul	0	3	10	48	90	99	25	3.8	433	583	6.0
check-N.ex	Accent II	4026	1164	89.7	80	31-Jul	8	29	51	81	99	99	28	4.0	470	663	5.0
check	NK-200	3917	1088	83.9	83	2-Aug	0	1	5	28	76	92	27	1.3	416	504	4.0
	Green EmperorxRoyal Green	4031	1415	109.1	74	31-Jul	1	7	15	48	93	99	23	1.5	449	583	5.5
U of M	MSPxA.Green/R.Green	3999	1297	100.0	80	1-Aug	1	7	16	48	90	98	24	2.5	463	588	6.0
U of M	Spreader IV	4029	997	76.9	84	1-Aug	0	1	10	40	92	99	24	2.8	410	561	3.0
U of M	Green Emperor	3976	1342	103.5	78	1-Aug	0	4	13	48	91	99	24	2.0	491	567	5.5
U of M	Forageur	3984	1293	99.7	85	2-Aug	0	0	2	21	81	97	30	2.3	434	511	4.5
	Fiesta IV	4027	1313	101.2	85	30-Jul	5	23	45	78	97	99	24	4.0	513	511	6.0
U of M	Green EmperorxArctic Green	4020	1415	109.1	76	30-Jul	3	13	28	60	96	99	24	2.0	472	565	5.0
	SR4600	4028	1250	96.4	75	31-Jul	7	28	58	83	96	99	24	3.0	501	546	5.5
McCarthy-Allied	MRSL-PR15	4056	1424	109.8	53	31-Jul	3	14	34	68	95	99	20	1.8	482	539	7.0
McCarthy-Allied	MRSL-PR16	4057	1391	107.2	68	31-Jul	3	11	25	60	92	98	23	2.8	493	532	7.0
McCarthy	N-6-16	4058	1050	81.0	42	31-Jul	1	7	15	43	81	95	20	1.8	393	565	7.0
McCarthy-Allied	A-6D	4055	1411	108.8	60	31-Jul	3	16	30	60	93	99	21	1.5	455	507	7.0
LSD @5% level			197	15.1	26	1.6	3	8	14	14	9	2	1.6	1.5	80	130	1.0
CV(%)			10	10	25	3	114	58	43	18	7	2	5	43	12	16	12

Experimental Design: RCB with 4 reps

%stand*- Most stand loss due to winterkill

Trial Mean = 1297#/acre

Seeding Rate=7#/acre

Planted 6/1/2016 With 120#/ac Linkert spring wheat

Table 3.

**2016 Perennial Ryegrass Winter Hardiness Variety Trial
St.Paul and Roseau, Mn.**

Variety	Seed lot	Winter Injury ¹		
		St.Paul	Roseau	Combined
Royal Green	3998	9.0	8.0	8.5
Green EmperorxArctic Green	4031	8.1	7.3	7.7
Green Emperor	3976	8.6	7.8	8.2
Gulf-annual	3983	9.0	9.0	9.0
Spreader III	3791	8.5	6.8	7.6
3999	4017	8.6	7.0	7.8
3999	4050	8.6	6.8	7.7
NK-200	3917	8.5	5.8	7.1
Accent II	4026	8.9	8.5	8.7
Forageur	3984	8.3	5.5	6.9
Forageur	4043	8.1	6.0	7.0
Arctic Green	3997	8.9	7.0	7.9
Spreader IV	4029	9.0	7.5	8.3
Spreader IIIxArctic Green	4030	8.8	7.0	7.9
LSD @5% level		0.8	1.9	1.2
CV(%)		6	18	11

Experimental design: RCB with 4 reps

Seeding Date:Roseau=9/5/2016 ; St.Paul=9/12/2016

¹-Winter Injury- 1=none; 9=dead

Table 4.

**2016-17 Perennial Ryegrass N Timing Fertility Trial--Large plot On Farm
Magnusson Farms- North of Roseau**

variety-Fiesta IV

Treatment ¹	Yield ²		Harvest	
	(#/acre)	% clean	Ht(in.)	Lodging ³
Fall + spring	1132*	84	23	3
Spring only	1202	84	22	3
LSD @5% level	NS	NS	NS	NS
CV(%)	12	2	2	46

Experimental Design: RCB w/3reps

Treatment¹-

Fall + Spring= 30#N /acre 10/18/2016 +110#N/acre 5/11/2017

Spring only= 140#N/acre all applied 5/11/2017

Yield²= #/acre clean seed

Lodging³- 1=upright;9=flat

* Fall split treatment in rep 3 yield was 220#/acre less than spring only fertilizing

Yields between treatments in rep 1 and 2 were almost identical.

No statistical difference found between treatment seed yields

Table 5.

2016-17 Perennial Ryegrass Fertility Trial
Magnusson Research Farm-Roseau,Mn

Trt#	Fertilizer Rate: N level	Application Timing	Seed Yield ¹		Harvest Date	Ht(in.) Harvest	Lodging ²		RCI ³	
			% mean	#/acre			Harvest	6/1	6/5	6/19
1	0		46.2	752	31-Jul	17	1.0	210	195	252
2	140+0+0	30-0-0--10/19	101.2	1647	31-Jul	26	6.8	430	510	644
3	140+0+0	30-0-0--10/19+40P-spring	108.1	1758	1-Aug	25	7.0	506	517	663
4	100+0+0	30-0-0--10/19	106.1	1726	31-Jul	23	5.0	447	476	584
5	140+0+0	30-0-0--9/15	94.0	1529	31-Jul	25	6.0	449	504	614
6	180+0+0	30-0-0--10/19	93.8	1526	1-Aug	25	7.3	466	510	687
7	140+0+0+20s	30-0-0-20s--10/19	104.1	1693	1-Aug	24	6.3	474	494	594
8	140+0+0	No fall N	90.5	1473	1-Aug	24	5.5	452	502	630
9	140+0+0	30-0-0--10/19(spring Liq)	101.6	1653	1-Aug	23	5.5	441	440	577
10	100+0+0	30-0-0--10/19(spring Liq)	100.5	1635	31-Jul	24	3.3	355	391	443
LSD @5% level			13.5	207	0.6	2	1.7	79	62	90
CV(%)			9	9	1	6	23	13	10	11

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

Mean yield(not including 0# N)= 1627#/acre

8-40-40 added to all plots 9/14/2016

Spring fertility treatments applied 5/6/2017

¹-Seed Yield- Clean seed yield of each treatment in LBS/Acre and % of trial mean(not including 0 rate)

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

Trt#	Season	Total #N	8-40-40 applied to all plots
1	0	No added N	
2	140	30#N oct-	
3	140	Add 0-40-0 spring	
4	100	30#N Oct-low N	
5	140	30#N sept-early w/P&K	
6	180	30#N Oct-Hi N	
7	140	30#N Oct- (17-0-0-20s AMS + 13-0-0)	
8	140	spring only N	
9	140	30#N liquid =10GPA 28%UAN-flat fan 6/10 +30#N Oct	
10	100	30#N liquid =10GPA 28%UAN-flat fan 6/10 +30N Oct	

Soil test results (samples taken from plots with 8-40-40 fall application)

5/5/2016	Depth	Olsen P	NH4O-K	% OM	PH	NO3-N
	0-6"	21 ppm	160 ppm	3.2	8	1.4
	6-24"					6.2

2016-17 Perennial Ryegrass Liquid Fertilizer Demo¹
Magnusson Research Farm-Roseau,Mn

Fertility ¹	Seed Yield #/acre	Harvest Ht(in.)	Harvest lodging
None added	485	18	1
60# N/acre	601	19	1.5
90# N/acre	872	21	2

Demo plot treatments were not replicated. 2 samples taken per plot for yield

Fertility2- 20 GPA of 28%UAN applied with flat fan sprayer 6/16/2017=60#N/acre

30 GPA of 28%UAN applied with flat fan sprayer 6/16/2017

No other fertilizer was applied to these plots.

Table 5a.

2011-16 Perennial Ryegrass Fertility Trial Summary
Magnusson Research Farm-Roseau,Mn

Trt. #	Total applied Nitrogen	Nitrogen Timing	Overall		Yield as % of Mean						
			Mean	2017	2016	2015	2014	2013	2012	2011	
1	100+0+0	Split ¹	100	104	90		92	96	112	108	
2	140+0+0	Split ¹	109	99	110	99	104	104	118	118	
3	140+0+0+20s	Split ²	105	102			110	99	----	----	
4	180+0+0	Split ¹	115	92	111		122	111	----	----	
5	100+0+0	(fall 8-40-40)spring	96		86		95	93	96	108	
6	140+0+0	(fall 8-40-40)spring	108	89	106		96	104	119	115	
7	140+0+0	Split ¹ +(0-40-0spring)	119	106	109	127	120	----	----	----	
8	140+0+0	Split ¹ +(90spring+20liq)	108	99			106	109	----	----	
9	140+0+0	30#N fall-NO added P OR K	83			84	81	----	----	----	
10	0	0	30	45	38	29	27	28	21	36	
LSD @5% level						12	20	11	16	11	12
CV(%)						9	16	8			

Experimental Design:RCB with 4 reps Variety=Arctic Green

2017 Trial mean(excluding 0-N fertilizer)=1663 #/ac.

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

²-Split-30#N-20#N ammonium sulfate+10#N urea applied fall and 110#N urea in early May

Spring fertilizer applied early May

Trt. #	Explanation of fertility treatments
1	30-40-40 applied Sept-Oct. / 70-0-0 applied early May
2	30-40-40 applied Sept.-Oct. / 110-0-0 applied early May (Standard)
3	30-40-40-20s applied Sept-Oct. / 110-0-0 applied early May
4	30-40-40 applied Sept-Oct./ 150-0-0 applied early May
5	8-40-40 applied Sept-Oct. / 100-0-0 applied early May
6	8-40-40 applied Sept-Oct. / 140-0-0 applied early May
7	30-40-40 applied Sept-Oct. / 110-40-0 applied early May
8	30-40-40 applied Sept-Oct. / 90-0-0 applied May / 6-9 gal. 28%UAN applied 6-20
9	30-0-0 applied October / 110-0-0 applied early May
10	No fertilizer added

Table 6.

2017 Perennial Ryegrass Herbicide Screen
Magnusson Research Farm-Roseau,Mn

Broadleaf Treatment ¹	Grass treatment ²	Seed yield (#/ac.)	Lodging ² Harvest	Ht.(in.)
2,4-D +Clarity (standard)	Tacoma	1682	5	22
2,4-D +Clarity	Acclaim Extra	1782	6	23
2,4-D +Clarity	Facet L	1540	5	23
2,4-D+Clarity + Prowl H2O	Tacoma	1669	5	24
2,4-D +Clarity+Outlook	Tacoma	1691	5	23
Callisto+Clarity	Tacoma	1709	6	22
Callisto-2+Clarity	Tacoma	1537	5	22
2,4-D +Clarity	None	1789	5	22
	LSD @ 5% level	192	NS	NS
	CV(%)	8	20	6

Experimental Design: RCB w/4reps

Variety-Arctic Green harvested 7/31/2017

Broadleaf Treatment¹- 5/31/2017

Grass Treatment²-6/7/2017

Acclaim Extra*- Does not have a safener added and can not be used on wheat

Trade Name	common name	AI/gallon	Product Rate	adjuvant
Acclaim Extra	fenoxaprop	.57#	1pt	1%COC
Tacoma 1EC	fenoxaprop	1#	10oz.	
Prowl H2O	pendimethalin	3.8#	2.5pt	
Callisto	mesotrione	4#	3oz.	1%COC
Callisto-2	mesotrione	4#	3oz.	1%MSO+2.5%AMS
Clarity	dicamba	4#	.75pt	
Outlook	dimethenamid	6#	1pt	
2,4-D amine 4	2,4-D amine	4#	.75pt	
Facet L	quinclorac	1.5#	1.5pt+2pt COC	

Table 7.

2017 Late Herbicide Applications on Perennial ryegrass

Magnusson Farms-North of Roseau,Mn

variety- Fiesta IV

trt#	Product	Rate	Seed Yield #/acre	Ht.(in.) 18-Jul	lodging* 18-Jul
1	Tacoma	10oz.	1709	22	5
2	Tacoma+2,4-DE(LV-6)	10oz+12oz	1445	23	6
3	2,4-DE(LV-6)	12oz.	1629	23	5
4	Curtail	2pt.	1890	22	5
5	UTC		1759	23	6
LSD @5% level			169	1	NS
CV(%)			5	3	28

Experimental Design: RCB w/3 reps

All applications made 7/3/2017

Growth stage 7/3/2017 - mid-pollen shedding

Applications made with 9' backpack sprayer at 26PSI

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Table 8.

2017 Acclaim/Tacoma Applications on Perennial ryegrass

Magnusson Farms- North of Roseau,Mn

variety- Fiesta IV

trt#	Product	Rate	Seed yield (#/ac.)	Sloughgrass Presence ¹	Lodging ² Harvest	Ht.(in.)
1	Acclaim Extra	1 pt.+1%COC	1473	0.0	2.5	23
2	Tacoma 1EC*	10oz	1511	0.5	4.0	24
3	No treatment		1509	6.5	3.0	24
LSD @5% level			NS	3	NS	NS
CV(%)			6	30	13	2

Experimental Design: RCB w/3 reps

Acclaim Extra*- Does not have a safener added and can not be used on wheat

sloughgrass presence¹-% of plot infested with sloughgrass

Lodging²- 1=erect;9=flat

Trade name	common name	AI/gallon	Rate
Acclaim Extra*	fenoxaprop	.57#	1 pt+1%COC
Tacoma 1EC	fenoxaprop	1#	10 oz
2,4-DE(LV-6)	2,4-D ester	6#	.75 Pt
Curtail	2,4-D amine+clopyralid	2#+.38#	2 Pt

Table 9.

**2016-17 Pre-Emergent Herbicide Applications to Perennial Ryegrass
Magnusson Research Farm-Roseau,Mn**

Treatment	Rate	Application date	Seed yield (#/ac.)	Harvest	
				Lodging ³	Ht.(in.)
Nortron	2 pt.	10/19	1891	6	24
Nortron	2 pt.	5/4	1793	6	23
Nortron	2pt+2pt	10/19+5/4	1682	6	24
Nortron ¹	4 pt.	5/4	1713	5	24
Outlook+Nortron	1 pt+2pt	10/19+5/4	1793	5	23
Outlook	1 pt	10/19	1711	5	23
Callisto	6oz.+25% NIS	5/4	1749	6	24
Callisto ²	3oz.+1% MSO+28% UAN	10/19	NH	NA	NA
No treatment			1820	6	24
		LSD @5% level	158	NS	NS
		CV(%)	6	21	3

Experimental Design: RCB w/4 reps
variety-Arctic Green

Nortron¹ - This 4 pt/acre spring treatment was only 1 plot treatment and not replicated.

Callisto²- These plots were dead

Fall applications made 10-19-2016 9:00am 48F wind WNW 8-15mph

5/4/2017 applications made wind 5mph 60F 3:00pm

Harvest date=8/2/2017

ALL plots received fall application of 2,4-D + Clarity and spring application of 2,4-D + Clarity, Assure II, Apogee, and Quilt in separate applications and fertilizer as per best management practices.

All treatment applications made with 10' bike sprayer w/ 11002 nozzels @ 28psi

Table 10.

2017 Ryegrass Fungicide Seed Production Trial 2 Northern Minnesota Locations

TRT # Product	Adjuvant	Rate/ac.	2017 Seed Yield (#/acre)			Lodging ²		Ht.(in.)	
			Mean	location1	location2	location1	location2	location1	location2
1 No treatment			1503	1629	1377	6	3.5	23	24
2 Quilt Xcel 2.2 SE	1%COC	14 oz.	1725	1858	1593	6.3	3	24	23
3 Quilt Xcel 2.2 SE+Warrior	1%COC	14oz+2oz	1767	1922	1611	6.5	4	23	23
4 Absolute 4.36 SC	1%COC	7.5 oz.	1653	1862	1444	5.8	3.3	23	23
5 Tilt	.25%NIS	4oz.	1659	1811	1506	6.5	3	24	23
6 Folicur	.25%NIS	5 oz.	1600	1796	1404	5.5	3.3	23	23
7 Aproach2.08	.25%NIS	9 oz.	1664	1909	1420	6.3	3.8	23	24
8 Aproach2.08+Tilt	.25%NIS	6 oz.+4oz.	1742	1909	1575	6.3	4.8	23	24
9 Aproach2.08+Tilt	.25%NIS	9 oz.+4oz.	1702	1838	1566	6.5	3	23	23
10 Priaxor	.25%NIS	6oz.	1739	1925	1553	6.3	3.5	23	23
	LSD @5% level		126	169	175	NS	NS	NS	NS
	CV(%)		5	6	8	12	34	6	5
2017 mean yield= 1675 #/acre									

Experimental Design= RCB with 4 reps

Location 1= Magnusson Research Farm- Roseau, Mn

Perennial ryegrass variety= Arctic Green

Harvest Date- 8/1/2017

Treatment applications- 6/27/2017

sunny 65F wind WNW 2-6 MPH

GS= fully headed-early bloom

Sprayer= CO2 backpack sprayer W/9' boom(6nozzel-18" spacing)

14GPA output @26PSI Flat fan tips- 11002XR

Location 2=Erickson Farm-North of Roseau, Mn

Perennial ryegrass variety= Defender

Harvest Date-7/27/2017

Treatment applications applied 7/7/2017

sunny 65F- 10:30am wind NNW 4-8MPH

GS=late pollen shedding

Sprayer= CO2 backpack sprayer W/9' boom(6nozzel-18" spacing)

14GPA output @26PSI Flat fan tips- 11002XR

Table 11.

2016-17 Ryegrass Fungicide Yield Summary

4 Locations-Roseau and Lake of the Woods

Product	Adjuvant	Rate/ac.	% of Mean		
			2016-17*	2017	2016
No treatment			86	89	83
Quilt Xcel 2.2 SE	1%COC	14 oz.	105	103	106
Quilt Xcel 2.2 SE+Warrior	1%COC	14oz+2oz		106	
Absolute 4.36 SC	1%COC	7.5 oz.	99	99	99
Aproach2.08	.25%NIS	6 oz.			99
Aproach2.08	.25%NIS	9 oz.	99	99	99
Aproach2.08+Tilt	.25%NIS	6 oz.+4oz.		104	
Aproach2.08+Tilt	.25%NIS	9 oz.+4oz.		102	
Trivapro SE	1%COC	13.7 oz.			102
Trivapro SE	1%COC	17 oz.			104
Tilt	.25%NIS	4oz.		99	
Folicur	.25%NIS	5 oz.	98	96	99
Prosaro SC	.25%NIS	6.5 oz.			105
Priaxor	.25%NIS	6oz.	105	104	106
LSD @5% level				8	12
CV(%)				5	8

2017 Mean Yield= 1675 #/acre

2016 Mean Yield= 1301 #/acre

*2Yr. Mean provided where available

Trade Name-	Common name	AI(#/gal)
Quilt Xcel 2.2 SE	azyoxystrobin+propiconazole	1.02+1.18
Absolute 4.36 SC	tebuconazole+triflozystrobin	2.18+2.18
Trivapro SE	benzovindiflupyr+azoxystrobin+propiconazole	.25+.92+1.04
Aproach 2.08	picoxystrobin	2.08
Tilt	propiconazole	3.6
Folicur	tebuconazole	3.6
Prosaro SC	prothioconazole+tebuconazole	1.76+1.76
Priaxor	fluxapyroxad+pyraclostrobin	1.39+2.78
Warrior II	Lambda-cyhalothrin	2.08

Table 12.

**2017 Growth Regulator Applications to Perennial Ryegrass
Magnusson Research Farm-Roseau, Mn**

Growth Regulator ¹	Rate	additive	Yield	Dry Matter	Ht.(in.)	Lodging ²
			#/acre	Tons/acre		
Palisade 2EC ³	.75pt	None	1782	2.9	22	3.0
Palisade 2EC ³	1.5pt	.25%NIS	1735	2.7	19	1.0
Palisade 2EC ³	.75pt	.25%NIS	1724	2.9	22	3.0
Palisade 2EC ³	.75pt	.25%NIS+2.5%AMS	1610	2.8	20	2.0
Apogee	8oz.	.25%NIS+2.5%AMS	1700	2.7	22	3.8
Apogee	8oz.	.25%NIS+3gal.AMS	1871	2.9	23	2.8
Apogee	8oz.	.25%NIS+3gal. UAN	1873	3.0	23	4.0
No treatment			1484	3.1	26	7.5
		LSD @5% level	182	0.3	2	1.0
		CV	7	8	5	21

Experimental Design: RCB w/4 reps Mean Yield 1723#/acre

Variety-Arctic Green

Growth Regulator¹- retail price of Palisade 2EC @ .75pt/ac and Apogee @ 8oz./acre both = \$27.50/acre.

Lodging² - 1= no lodging; 9=flat

All applications- 6/7/2017 GS=Late boot-5% heading

Harvest Date- 7/31/2017

Apogee- Prohexadione-calcium 27.5%

Palisade 2EC- Trinaxapac-ethyl 2#/gal

Rate³- The most currently available formulation is Palisade EC. The formulation used in this trial was Palisade 2EC.
Doubling the rates of the Palisade 2EC rates would = the equivalent rate of Palisade EC.

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Table 13.

**2016 Fall Plant- Perennial Ryegrass Residue Management Trial
Magnusson Research Farm-Roseau, Mn**

Residue Management	Seed yield % stand	
	#/acre	6/27/17
1-Ryegrass+ wheat	1920	35
2-Ryegrass+Wheat *	1865	30
3-Ryegrass + Wheat-	1927	50
Clip 5" Nov.11-2016		
	LSD @5% level	NS
	CV(%)	4
		NS
		15

Experimental Design:RCB w/3 reps Variety-Arctic Green

Seeding date - 8/23/2016

Hege plot seeder- 6" rows

Treatments- Ryegrass 6#/ac. + 20# Rollag wheat(6" rows)

1-Ryegrass+ wheat

2-Ryegrass+Wheat *- No spring treatment imposed as initial stands looked unacceptable

3-Ryegrass + Wheat- Clip 5" Nov.11-2016 Wheat 12-16" tall

Table 14.

2016 Fine Fescue Variety x Fertility Trial
Magnusson Research Farm- Roseau,Mn

Trt#	Species-variety	Fertility ¹		2017	10/18/2016		5/18/2017		RCI ³	Harvest	
				Yield(#/ac.)	%stand	Vigor ²	%stand	Vigor ²		Date	Lodging ⁴
1	Hard fescue-MNHD-15	0	Sept	1430	80	3.7	83	4.7	345	3-Jul	1.0
2	Hard fescue-MNHD-15	40	Sept	1807	77	5.0	83	5.7	477	3-Jul	2.3
3	Hard fescue-MNHD-15	80	Sept	1848	77	4.3	83	6.0	562	3-Jul	4.0
4	Hard fescue-MNHD-15	20/20	Sept/April	1587	80	4.0	87	4.7	408	3-Jul	3.0
5	Hard fescue-MNHD-15	40/40	Sept/April	1634	87	4.3	83	5.0	384	3-Jul	3.3
6	Sheep fescue-Quatro	0	Sept	759	83	4.7	83	5.3	333	3-Jul	1.0
7	Sheep fescue-Quatro	40	Sept	792	83	5.3	78	5.3	378	3-Jul	1.0
8	Sheep fescue-Quatro	80	Sept	1204	77	5.7	83	5.7	507	3-Jul	3.0
9	Sheep fescue-Quatro	20/20	Sept/April	1009	80	5.3	80	5.7	382	3-Jul	2.7
10	Sheep fescue-Quatro	40/40	Sept/April	1012	80	6.3	80	6.3	490	3-Jul	4.0
11	Chewings fescue-Windward	0	Sept	1536	80	7.0	85	6.0	392	10-Jul	5.3
12	Chewings fescue-Windward	40	Sept	1656	83	7.0	82	6.0	448	10-Jul	6.3
13	Chewings fescue-Windward	80	Sept	1677	83	7.3	82	6.7	550	12-Jul	7.7
14	Chewings fescue-Windward	20/20	Sept/April	1775	87	7.7	85	6.3	390	12-Jul	6.7
15	Chewings fescue-Windward	40/40	Sept/April	1825	83	7.3	82	5.7	407	12-Jul	7.3
16	Strong creeping red fescue-Cindy Lou	0	Sept	1675	80	7.0	82	7.0	372	12-Jul	1.3
17	Strong creeping red fescue-Cindy Lou	40	Sept	1577	87	8.0	88	7.3	405	12-Jul	5.0
18	Strong creeping red fescue-Cindy Lou	80	Sept	1731	87	7.7	85	7.7	559	12-Jul	6.3
19	Strong creeping red fescue-Cindy Lou	20/20	Sept/April	1540	83	7.0	85	6.3	380	12-Jul	3.0
20	Strong creeping red fescue-Cindy Lou	40/40	Sept/April	1572	87	7.0	85	7.0	468	12-Jul	6.0
21	Slender creeping fescue-Shoreline	0	Sept	883	87	8.0	87	6.7	263	9-Jul	3.7
22	Slender creeping fescue-Shoreline	40	Sept	1082	90	9.0	88	6.3	363	12-Jul	7.0
23	Slender creeping fescue-Shoreline	80	Sept	1152	83	8.7	85	7.3	474	12-Jul	7.7
24	Slender creeping fescue-Shoreline	20/20	Sept/April	1087	83	8.7	83	6.7	381	12-Jul	8.0
25	Slender creeping fescue-Shoreline	40/40	Sept/April	795	90	8.0	88	7.3	356	12-Jul	8.3
LSD @5% level				274	8	1.1	6	1.1	75	2	2.1
CV(%)				12	6	10	4	10	11	12	28

Experimental Design=RCB w/3Reps

Seeded 7/7/2016 @ 5#/acre in 6" rows with Hege plot seeder

Fertility¹- rates in #N/acre all in September or split 1/2 Sept.20 ,2016 + 1/2 May 8, 2017

Vigor²-1=least; 9=best

RCI³-relative chlorophyll index- higher number=more chlorophyll(greener) than lower numbers

RCI readings taken 5/12/2017 full sun-1:00PM

Lodging⁴- 1=no lodging;9=flat

Applied to all plots-

.5 Pt. 2,4-D Amine 4+ .75 Pt. Clarity 9/25/2016

Fusilade @ 10oz.+ .5%HCMSO

5/6/2017 wind ENE 6-12mph 12:00 60F

8-40-40 applied to all plots 9/15/2016

Table 15.

2016-17 MN-HD Hard Fescue Herbicide Screen
Magnusson Research farm-Roseau,Mn.

Treatment	Rate/Adjuvant	%infestation ¹									
		Seed Yield-#/acre			foxtail barley	% injury ²		Lodging ³ At Harvest-2016	Ht (in.)	stand ⁴	
		2016	2017	2Yr Ave.		6/6/16	6/23/16			4/18/16	5/7/17
1-Section 2	12oz+1%COC	35	605	320	0	80	87	1.0	6	93	87
2-Fusilade ⁴	10oz.+1%COC	1789	851	1320	1	0	0	5.3	27	87	77
3-Callisto	3oz.+1%COC+2.5%-28%N	1552	801	1176	8	12	0	4.7	26	90	70
4-Clarity	.75pt	1629	584	1107	20	0	0	5.0	27	83	63
5-2,4-D amine	.75pt	1451	813	1132	13	0	0	5.7	27	93	78
6-2,4-D+Clarity	.75pt+.75pt.	1341	863	1102	33	0	0	4.7	25	90	73
7-UTC		1439	946	1193	25	0	0	4.0	27	93	80
	LSD @5% level	393	307	302	14	2	4	2.0	2	NS	NS
	CV(%)	16	22	16	56	8	17	28	5	15	22

Experimental Design:RCB with 3 reps

¹-%infestation of foxtail barley 6-22-2016

All plot treatments applied on 5/6/2017

²%injury- Visual %rating of grass/seed head suppression.

12:00pm 60F wind ENE 6-12mph

³lodging-1=no lodging; 9= flat

CO2 bike sprayer w 10' boom 12GPA @27psi

⁴stand-visual rating prior to herbicide application

⁵ Fusilade had good sloughgrass and foxtail barley control

Stand- variable in areas with seeder skips. Visual %stand notes taken prior to herbicide application

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

Fertility application- 60-40-40 10/25/2015 and 10/18/2016

Plots clipped 7/25/16 and straw removed 7/28/2016

Treatment applications 5/10/2017 GS= vegetative / early boot

Treatment applications 5/20/2016 GS=20%heading

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

Table 16.

2017 Kernza Herbicide Screen
Estling Farms- Magnusson farms

Trt#	Pre-emergent post applied Trade Name	applied= 5/3/2017 6/1/2017 Rate + Adjuvant	Relative seed yield*	Observations
1	Dual II Magnum	1.5pt. (standard)	3.3	no crop effect. Minimal weed control
2	Dual II Magnum	3pt.	3.3	Slight delay in maturity. Some broadleaf suppression. Few annual grasses
3	Callisto+ Dual II	6oz.+5%DestinyHC+ 1.5pt.	4.7	Some crop suppression. Good general weed control
4	2,4-D LV6 + Dual II	.5pt.+ 1.5pt.	2.7	no crop effect. Good broadleaf control
5	Outlook	1pt.	4.0	slight crop suppression. Better general preemergent weed control than Prowl
6	Diuron	3pt.	3.3	more crop suppression than outlook but acceptable. Good preemergent weed control
7	Norton	2pt.	3.0	no crop effect.
8	Boundary6.5ec	1.5pt.	3.3	slight crop suppression(acceptable) but good weed control
9	Authority Elite	1.5pt.	6.0	unacceptable crop tolerance
10	EspAnade 200SC	5oz.	4.7	marginally acceptable crop tolerance. Good general weed control
11	No treatment		3.3	heavy weed competition
12	Prowl H2O	2.5pt.	3.0	no crop effect. Some annual grass and lambsquarter control but otherwise weedy
13	Valor EZ	2oz.	2.3	no crop effect. Weedy and no observed control of weeds present
<u>Post-emergent</u>		6/3/2017		
14	2,4-D a+ Sterling Blue	3/4pt.+3/4pt.	4.7	good crop tolerance
15	Curtail + Sterling Blue	2pt.+3/4pt.	4.3	good crop tolerance- better weed control
16	Callisto + Sterling Blue	3oz+1%COc+ 3/4pt.	6.3	moderate/some crop injury
17	Affinity tank mix + 2,4-D LV6	.8oz.+ .5pt.+ .25%NIS	3.0	Good crop tolerance. Some volunteer ryegrass and bluegrass suppression
18	Express w/totalsol +2,4-D LV6	.3oz.+ .5pt.+2.5% UAN	5.7	good crop tolerance. Some ryegrass suppression
19	Atrazine	3pt.+1%COc	7.3	unacceptable crop tolerance. Good weed control except sloughgrass
20	Wolverine	13.5oz.+2.5%AMS	3.3	good crop tolerance. Cockle still present. Some bluegrass spp and redtop suppression
21	Facet L	3pt.	3.3	good crop tolerance.
22	Beacon	.4oz+.25%NIS	9.0	crop dead
23	Axial XL	1 pt.	2.7	good tolerance. Wild oat and some other grasses controlled
24	Callisto* + Sterling Blue	3oz+2.5%COc+ 3/4pt	4.0	some crop suppression. Better than #16. however--?

*Observations/ seed yield - 1=good yield ;9=worst yield relative to other treatments
 based on 2 reps at Magnusson farm and 1 replication on Estling farm
 Apply with bicycle sprayer 12gpa @ 28psi
 Plot size= 10'x30'

Magnusson Farms location- 3mi. West and 1mi. North of Roseau

Volunteer canola a serious problem where not controlled by early season herbicides

Estling Farms location-5mi. North and 2mi.west of Roosevelt Mn

Kernza stand thin and variable.

Weed pressure and species presence varied by location in the field

Trt#	Trade name	Common name	Active Ingredient
3,16,24	Callisto	mesotrione	4#/gal
4,17,18	2,4-D LV6	2,4-D ester	6#/gal
14	2,4-D Amine 4	2,4-D amine	4#/gal
15	Curtail	2,4-D amine+clopyralid	2#+.38#/gal
14-16,24	Sterling Blue	dicamba	4#/gal
17	Affinity tank mix	thifensulfuron+tribenuron	40%+10%
18	Express w/totalsol	tribenuron	50%
20	Wolverine	fenoxypop+pyrasulfotole+bromoxynil	.38#+.17#+.42#/gal
1-4	Dual II Magnum	metalochlor	7.64#/gal
5	Outlook	demethenamid	6#/gal
6	Diuron 4L(Karmex)	Diuron	4#/gal
7	Norton	ethofumesate	4#/gal
8	Boundary6.5ec	metalochlor+metrabuzin	5.25#+1.25#/gal
9	Authority Elite	sulfentrazone+metalachlor	.7#+6.3#
10	EspAnade 200SC	indaziflam	1.67#/gal
12	Prowl H2O	pendamethalin	3.8#/gal
13	Valor EZ	flumioxazin	4#/gal
19	Atrazine 4L	atrazine	4#/gal
21	Facet L	quincloroc	1.5#/gal
22	Beacon	primasulfuron	75%
23	Axial XL	pinoxiden+adjuvunct	.42#/gal

Table 17.

**2015 - 2017 Intermediate Wheatgrass
Fertility x Row Spacing Trials
Roosevelt, MN and Roseau, MN**

N Rate	<u>2015</u>			
	<u>LOW</u>		<u>Roseau</u>	
	6" rows	24" rows	6" rows	24" rows
0	778	546	1181	510
20	875	624	1300	513
40	865	430	1429	621
60	940	521	1151	481
80	851	456	1117	527
	<u>2016</u>			
0	55	107	125	306
20	19	234	123	365
40	134	290	201	464
60	110	280	214	689
80	152	335	239	670
	<u>2017</u>			
0	174	76	57	20
20	141	109	93	42
40	321	147	66	30
60	391	115	179	105
80	300	180	296	192

Grain seed yield expressed in LBS./Acre

**2015 - 2017 Intermediate Wheatgrass
Nitrogen Rate x PGR* -St.Paul, Mn**

N rate	<u>2015</u>		
	No PGR	Apogee	Palisade
0	413	396	690
40	452	510	764
80	453	343	712
	<u>2016</u>		
0	275	674	509
40	515	482	945
80	318	254	714
	<u>2017</u>		
0	189	228	420
40	184	236	415
80	170	237	269

Grain seed yield expressed in LBS./Acre

PGR*= plant growth regulator

Acknowledgement-

Data provided by Dr. Jake Jungers- University of Minnesota

Table 19.

2017 Spring Wheat Sulfur Fertility Trial
Magnusson Research Farm-Roseau,Mn

Fertility Treatment ¹	Yield ²	% Protein	Test Wt / Harvest		RCI ³			Sulfur*
			Bu.	Ht(In.)	06/19/17	07/05/17	07/27/17	Soil-SO4(ppm)
1-0	93	14.7	61.1	33	388	607	549	16
2-15B	91	14.9	61.6	34	388	664	629	NA
3-15IF	93	15.1	61.5	34	356	631	575	NA
4-30B	94	15.1	61.4	33	392	626	595	23
5-30IF	91	15.4	61.6	33	306	683	580	25
LSD @5% level	NS	0.5	NS	NS	NS	58	NS	
CV(%)	3	2	1	4	4	6	10	

Experimental Design: RCB w/4 reps

Planted 5/18/2017 harvested 8/18/17

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

Soil test prior to fertilizer application 5/5/2017 0-6" S- SO4 26ppm ; PH 6.9 ;

Nitrate 11#/ac Olson P= 4ppm K=144ppm OM 2.7%

Soil test Sulfur* sampled 0-6" after harvest-8/26/2017

8-40-40 applied to all plots 5/5/2017. 140#/acre total Nitrogen added to all plots with broadcast sulfur plot treatments , prior to final seedbed preparation 5/8/2017.

Fertility Treatment¹

1-0 No added sulfur

2-15B 15# AMS source sulfur broadcast prior to final seedbed prep

3-15IF 15# AMS source sulfur applied down the tube with seed at planting

4-30B 30# AMS source sulfur broadcast prior to final seedbed prep

5-30IF 30# AMS source sulfur applied down the tube with seed at planting

Yield²- Bushels/acre corrected to 12% moisture

RCI³- Relative Chlorophyll Index- higher number= more chlorophyll

6/19=10:45am full sun no color differences observed

7/5=3:30pm full sun full flag leaf extended

7/27=3:00 full sun