

PROGRESS REPORT ON GRASS SEED PRODUCTION RESEARCH

prepared by

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Grass-Legume Seed Institute Presentation Roseau, MN - February 15, 2017

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#/acre with spring wheat
Banvel+ 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 100-0-0 applied early to mid-May, 300 - 600 GDD
Banvel+ 2,4-D amine (0.75+0.75 pint) applied late May, 700 - 900 GDD
Tecoma or Assure (8-10 oz) applied early June, 800 - 1,000 GDD
Apogee (6-8 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 5-6#/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 1967-2016.

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	-3.35	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	7.42	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	1.80	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	2.77	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	-4.19	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	-3.41	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
50 year average annual precipitation															
22.51															
Mean =															
38.2															
Mean temperature 1991-2016 =															
38.2															

*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.

2015 Perennial Ryegrass Seed Production Variety trial
Magnusson Research Farm-Roseau,Mn

Source	Variety ⁴	seed lot	Seed Yield		Lodging ¹ Ht.(in.)		Harvest date	RCI ²			%Heading			
			% of mean	#/ac.	Harvest	Harvest		6/6	6/13	7/10	6/6	6/11	6/19	6/23
1	McCarthy TY-13	4024	122	1428	7.0	22	27-Jul	698	664	316	6	28	86	97
2	U of M MSPxArctic Green	4020	116	1359	7.0	24	27-Jul	654	713	324	10	40	86	97
3	McCarthy PR-2-14	4022	114	1333	6.3	23	27-Jul	712	684	332	9	40	91	99
4	U of M Spreader IIIxArctic Green	4011	113	1331	7.0	25	27-Jul	667	653	333	6	33	87	96
5	U of M Arctic Green	3997	113	1328	7.5	24	27-Jul	753	694	311	9	45	90	97
6	McCarthy PR-3-14	4023	111	1306	6.0	23	27-Jul	682	669	318	14	48	91	98
7	McCarthy DN-08	3989	106	1246	5.8	22	27-Jul	661	659	321	10	38	91	97
8	Pickseed Fiesta IV	4027	106	1241	7.3	24	27-Jul	696	709	300	14	43	88	98
9	U of M MSPxA.Green/R.Green	3999	101	1190	7.8	26	27-Jul	661	724	320	1	20	80	96
10	U of M Green Emperor(MSP)	3976	95	1117	7.3	25	27-Jul	667	617	299	3	19	78	94
11	U of M Spreader III	3791	91	1068	7.5	26	27-Jul	657	578	318	0	10	78	94
12	Jacklin Accent II ³	4026	90	1059	7.0	24	27-Jul	612	633	309	13	48	94	99
13	U of M Royal Green	3998	87	1019	6.8	25	27-Jul	636	674	317	4	28	91	98
14	Pickseed SR 4600	4028	85	1001	7.0	24	27-Jul	690	659	292	18	50	94	99
15	U of M Forageur	3984	76	888	8.0	24	3-Aug	540	513	293	0	2	55	88
16	check NK-200	3917	74	863	7.0	28	3-Aug	616	593	300	3	18	78	95
LSD @5% level			14	170	1.8	2	0	141	74	27	10	22	13	4
CV(%)			10	10	18	6	0	15	8	6	95	48	11	3

Experimental design: RCB with 4 reps

6#/acre ryegrass seeded with 120#/acre Rollag wheat on 6/1/2015

¹-Lodging-9=flat;1=upright²-RCI-relative chlorophyll index- higher number=more chlorophyll³- Accent yields were inconsistent among replicates and may not be reliable.⁴-Nitrogen availability seemed higher than optimal for some varieties

Table 3.

**2015 Perennial Ryegrass Winter Hardiness Trial
St.Paul and Roseau , Mn**

	Variety	lot#	Winter Injury ³				Fall Vigor ¹	Fall Growth ²
			Roseau mean	St.Paul 4/21/16	Roseau 4/23/16	Roseau 4/29/16		
check	Accent II	4026	1.5	1.3	2.0	1.0	4.8	12
U of M	Arctic Green	3997	1.5	1.5	2.0	1.0	3.8	13
U of M	Forageur	3984	1.5	1.3	2.0	1.0	6.0	10
U of M	Green Emperor	3976	1.4	1.3	1.8	1.0	4.8	11
check	Gulf-annual	3983	6.9	3.8	7.0	6.8	9.0	9
U of M	MSPxA.Green/R.Green	4017	1.5	1.0	2.0	1.0	5.8	10
U of M	MSPxArctic Green	4031	1.4	1.3	1.8	1.0	4.8	13
check	NK-200	3917	1.5	1.3	2.0	1.0	5.5	12
DLF	PRWH4-12	4033	1.6	1.3	1.8	1.3	5.0	11
DLF	PRWHNGS-1-14	4034	1.4	1.3	1.8	1.0	5.0	11
DLF	PSG1037-12K	4035	1.4	1.0	1.8	1.0	4.3	12
DLF	08-20Lp AB	4032	1.4	1.0	1.8	1.0	4.0	13
Check	Quebec	4037	1.5	1.0	2.0	1.0	4.5	12
U of M	Royal Green	3998	1.5	1.0	2.0	1.0	5.5	10
UM	Spreader III	3791	1.4	1.3	1.8	1.0	4.5	13
U of M	Spreader IIIxArctic Green	4030	1.4	1.5	1.8	1.0	4.5	13
U of M	Spreader IV	4029	1.9	1.3	2.3	1.5	4.5	13
Pickseed	SR 4600	4028	1.4	1.3	1.8	1.0	5.5	11
DLF	WH-PR-11-3	4036	1.4	1.5	1.8	1.0	5.0	11
UM-wh	11-758-4	1	1.5	1.3	2.0	1.0	4.5	12
UM-wh	11-764-7	2	1.7	1.3	2.3	1.0	4.3	13
UM-wh	11-766-8	3	1.5	1.0	2.0	1.0	4.5	12
UM-wh	11-774-12	4	1.7	1.8	2.0	1.3	4.3	12
UM-wh	11-778-14	5	1.4	1.0	1.8	1.0	4.5	13
UM-wh	11-782-4	6	1.7	1.3	2.0	1.3	5.3	12
UM-wh	11-788-9	7	1.5	2.8	2.0	1.0	4.5	13
UM-wh	11-800-15	8	1.5	1.0	2.0	1.0	5.0	12
UM-wh	11-804-6	9	1.7	1.3	2.0	1.3	5.5	12
UM-wh	11-808-10	10	1.5	1.3	2.0	1.0	5.3	13
UM-wh	11-810-2	11	1.7	1.3	2.0	1.3	4.5	12
UM-wh	11-818-9	12	1.3	1.3	1.5	1.0	5.3	13
UM-wh	11-826-7	13	1.7	1.3	2.0	1.3	4.3	13
UM-wh	11-836-2	14	1.4	1.0	1.8	1.0	5.0	12
UM-wh	11-842-3	15	1.6	1.3	1.8	1.3	4.3	13
UM-wh	11-854-7	16	1.5	1.3	2.0	1.0	4.0	13
UM-wh	11-866-10	17	1.5	1.0	2.0	1.0	4.8	12
UM-wh	11-868-8	18	1.6	1.3	1.8	1.3	4.8	12
UM-wh	11-870-6	19	1.5	1.5	2.0	1.0	4.8	13
UM-wh	11-888-14	20	1.4	1.0	1.8	1.0	5.0	13
UM-wh	11-898-3	21	1.7	2.3	2.0	1.3	4.3	13
	LSD @5% level		0.4	1.2	0.5	0.5	1.0	1
	CV(%)		17	64	28	19	16	6

Experimental design: RCB with 4 reps

Seeding Date:Roseau=9/1/2015 ; St.Paul=9/14/2015

¹-Vigor 10/20/2015- 10=most plant vigor; 1=least vigor/Roseau

²- September date when growth= .5"-.75" -Roseau

³-Winter Injury- 1=none; 9=dead

Table 4.

**2016 Liquid N Applied to Green Emperor Perennial Ryegrass
Magnusson Farms-Roseau,Mn**

	Seed Yield (#/ac)	RCI ¹	Ht(in.) At Harvest	Lodging ²
1 None added	997	171	27	8
2 Add 30-6-0	1148	184	26	8
LSD @5% level	NS	NS	NS	NS
CV(%)	10	3	4	0

Experimental Design: RCB with 3 reps

Plot size= 25'x 600' with 2 reps Harvest date-7/27/2016

¹-RCI-Relative Chlorophyll Index-Higher value=more chlorophyll

²-Lodging-1=upright; 9=flat

30-6-0 = (82% 28-0-0 + 18% 10-34-0)

Applied 6/2/2016 with 25' PTO tractor sprayer

Total sprayer output with streamer nozzels= 18GPA

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Table 5.

**2016 Liquid N Applications to Arctic Green Perennial Ryegrass
Magnusson Research Farm-Roseau,Mn**

trt#	Added Fertilizer	Application nozzel	Seed Yield (#/ac)	RCI ¹ 7/15	Color ² 7/15
3	No Treatment		897	256	5.0
4	30-6-0	Flat fan	928	274	6.3
5	30-6-0	streamer	843	272	6.0
6	90-18-0	Flat fan	846	315	7.5
7	90-18-0	streamer	941	331	7.3
	LSD @5% level		NS	49	1.5
	CV(%)		13	11	15

Experimental Design: RCB with 4 reps

Applications made with CO2 backpack sprayer with either 11002 XR T-Jet nozzel(flat fan) or 3-hole nozzel(streamer) at 18GPA. All applied 6/23/2016

¹-RCI-Relative Chlorophyll Index-Higher value=more chlorophyll

²-Color-visual rating- 1=lightest green; 9=darkest green

Liquid fertilizer composition:

28%N=10.67#/gal (3#N/gal)

10-34-0=11.63#/gal (1.2#N+4#p2o5 /gal)

Table 6.

2015-16 Arctic Green Perennial Ryegrass Fertility Trial Magnusson Research Farm-Roseau,Mn

Fertilizer Rate: Application		Seed Yield ¹		Ht(in.)	Lodging ²		RCI ³		
N level	Timing	% mean	#/acre	Harvest	7/11	Harvest	6/6	6/13	7/11
1	0	38	460	18	1.0	1.0	209	179	173
2	140+0+0 add 30-40-0---9/29	108	1313	23	6.5	7.0	665	615	245
3	140+0+0 add 0-40-0---5/1	109	1333	23	7.3	7.0	672	615	264
4	100+0+0 30-0-0--9/29	90	1099	23	6.5	5.8	611	539	235
5	140+0+0 30-0-0--9/29	110	1337	23	6.0	6.0	679	635	259
6	180+0+0 30-0-0--9/29	111	1357	24	7.3	7.3	688	630	284
7	100+0+0 No fall N	86	1052	24	3.8	4.5	595	596	254
8	140+0+0 No fall N	106	1293	23	3.8	5.3	628	671	286
9	140+0+0 30-0-0--9/29(spring Liq)	101	1228	24	5.8	7.0	608	597	270
10	140+0+0 30-0-0--9/29(spring Liq)	100	1222	24	6.0	6.5	582	615	264
11	100+0+0 30-0-0--9/29(spring Liq)	92	1128	22	4.5	4.5	553	463	252
LSD @5% level		12	148	2	1.5	1.2	88	64	23
CV(%)		9	9	5	20	14	10	8	6

Experimental Design: RCB with 4 reps

Best management practices used on all plots

Blanket application of 8-40-40 applied to entire trial area on 9/8/2015

Spring dry fertilizer applications=5/5/2016

¹-% of mean yield is mean of all treatments except no treatment. **Trial mean=1220#/acre**

²-Lodging-1=upright;9=flat

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

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

Trt. # Explanation of fertility treatments(all received 8-40-40 on 9/8/2015)

- 1 No additional
- 2 30-40-0 late September+110-0-0 5/5.
- 3 30-0-0 late September+110-30-0 5/5.
- 4 30-0-0 late September +70-0-0 5/5.
- 5 30-0-0 late September +110-0-0 5/5 (**Standard**).
- 6 30-0-0 late September +150-0-0 5/5.
- 7 100-0-0 5/5.
- 8 140-0-0 5/5.
- 9 30-0-0 late September + 80-0-0 5/5 + 30-0-0 liquid/streamer nozzels 6/19.
- 10 30-0-0 late September + 80-0-0 5/5 + 30-0-0 liquid/flat fan nozzels 6/19.
- 11 30-0-0 late September + 40-0-0 5/5 + 30-0-0 liquid/flat fan nozzels 6/19.

Table 6a.

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

Trt. #	Total applied Nitrogen	Nitrogen Timing	Yield as % of yearly mean						
			Average	2016	2015	2014	2013	2012	2011
1	100+0+0	Split ¹	100	90		92	96	112	108
2	140+0+0	Split ¹	109	110	99	104	104	118	118
3	140+0+0+20s	Split ²	105			110	99	----	----
4	180+0+0	Split ¹	115	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	106		96	104	119	115
7	140+0+0	Split ¹ +(0-40-0spring)	119	109	127	120	----	----	----
8	140+0+0	Split ¹ +(90spring+20liq)	108			106	109	----	----
9	140+0+0	30#N fall-NO added P OR K	83		84	81	----	----	----
10	0	0	30	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

2016 Trial mean(excluding 0-N fertilizer)=1220 #/ac.

¹-Split-30-40-40 applied fall and remainder in spring²-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 7.

**2015-16 Ryegrass Phosphorous Trial
Magnusson Research Farm-Roseau,Mn.**

TRT#	Fertility Treatment ⁴	Fertilizer timing ¹	Seed Yield		RCI ²		lodging ³		Ht(in.) 7/26	Whole plant tissue samples 7/15/2016							
			#/acre	% of mean	6/13	7/11	7/11	7/26		B	Ca	I	Mg	Mn	N	P	K
1	0-20-40	EF	1150	99.5	610	249	4.8	4.0	24								
2	0-40-40	EF	1262	109.2	641	233	6.0	5.8	24	5	0.25	50	0.3	70	0.9	0.14	1.3
3	0-60-40	EF	1259	108.9	618	255	7.5	7.0	24								
4	0-80-40	EF	1237	107.0	648	256	7.8	6.5	25	6	0.27	60	0.35	71	1.1	0.17	1.3
5	0-0-40	EF	822	71.1	418	301	2.8	2.0	21								
6	0-20-40	SF	1226	106.1	692	255	6.3	5.5	24								
7	0-40-40	SF	1322	114.4	668	246	8.5	7.3	24	3	0.26	55	0.3	47	1.2	0.15	1.3
8	0-60-40	SF	1288	111.4	688	245	8.3	7.5	24								
9	0-80-40	SF	1288	111.4	703	244	8.5	7.8	25	4	0.25	57	0.36	62	1.1	0.17	1.2
10	0-0-40	SF	841	72.8	402	348	2.0	2.3	21	3.5	0.26	55	0.25	59	1.5	0.11	1.2
11	0-20-40	S	1079	93.3	535	260	4.3	4.3	22								
12	0-40-40	S	1184	102.4	624	262	4.5	5.0	23								
13	0-60-40	S	1213	104.9	611	278	5.5	4.5	23								
14	0-80-40	S	1177	101.8	660	270	5.3	6.3	23								
15	0-0-40	S	896	77.5	413	314	1.8	1.8	21								
16	0-20-40	F/S	1217	105.3	671	260	7.0	6.3	25								
17	0-40-40	F/S	1395	120.7	721	243	8.3	7.8	25	5	0.32	50	0.34	59	1.1	0.16	1.5
18	0-60-40	F/S	1395	120.7	715	252	8.3	8.0	25								
19	0-80-40	F/S	1251	108.2	711	237	7.8	7.8	23	5	0.26	57	0.34	78	1.4	0.21	1.3
20	0-0-40	F/S	972	84.1	453	268	4.0	4.3	22	4	0.21	41	0.25	71	1.6	0.1	1.2
21	0-0-0	NO	810	70.1	409	275	2.5	2.3	20	3	0.21	51	0.26	58	1.3	0.12	0.9
LSD @5% level			164	14	100	38	2.0	1.7	2	1.7	0.08	NS	0.06	18	0.3	0.05	0.4
CV(%)			10	10	12	10	25	22	6	18	13	23	8	13	10	16	15

Experimental Design:RCB with 4 reps

Variety-Arctic Green seeding rate-5#/acre

All plots received 30-0-0 10/20/2016 & 90-0-0 5/1/2016

Seed yield trial mean=1156 #/acre

Harvest date=7/26/2016

¹Fertilizer timing

EF=Early Fall-9/7/2015

SF=Standard Fall-10/20/2015

S=Spring greenup-5/1-2016

F/S=Fall applied 50% 10/20/2015 + spring applied 50% 5/1/2016

²RCI-Relative chlorophyll index- higher number=more chlorophyll³Lodging-1=upright; 9=flat⁴-Rate - All plots received 140#N/acre with 30#N in fall and 110#N in spring

Soil test results after harvest=

5/5/2016 (prior to fertilizing)		Olsen P	NH4O-K	% OM	PH
		3 ppm	94 ppm	3.4	8.2
Trt#	Rate	Olsen P	NH4O-K	% OM	PH
10/20/2016	21	2 ppm	106ppm	3.4	8.3
	7	7 ppm	129ppm	3.4	8.5
	9	10ppm	129ppm	3.3	8.5

Table 8.

**2015-16 Ryegrass Liquid Phosphorous Trial
Magnusson Research Farm-Roseau,Mn.**

Trt#	Phosphorous		Seed Yield #/acre	6/13	7/11	7/11	7/26	7/26
	Rate ¹	Formulation ²		RCI ³		lodging ⁴		ht.
1	0-40-40	DF	1404	671	257	8.0	7.5	25
2	0-40-40	LF	1382	713	271	8.3	7.3	25
3	0-40-40	DS	1397	722	283	5.8	7.0	24
4	0-40-40	LS	1391	688	277	6.5	7.3	24
5	0-80-40	DF	1326	673	241	7.8	7.3	25
6	0-80-40	LF	1324	707	252	7.8	7.0	24
7	0-80-40	DS	1190	545	267	4.3	5.3	23
8	0-80-40	LS	1351	705	266	6.5	7.3	24
9	0-0-40	OF	1045	504	301	2.8	4.8	22
LSD @5% level			115	79	28	1.7	1.4	2
CV(%)			6	8	7	18	14	5

Experimental design:RCB with 4 reps

Harvest date=7/26/2016

Liquid applications made with backpack sprayer with streamer jet nozzels

Fall applications-9/7/2015 ; Spring applications- 5/1/2016

¹-Rate - All plots received 140#N/acre with 30#N in fall and 110#N in spring²-Phosphorous Formulation- (DF)=dry formulation,(LF)=liquid formulation,(OF)= none added³RCI-Relative chlorophyll index- higher number=more chlorophyll⁴Lodging-1=upright; 9=flat

Liquid formulation=

10-34-0= 1.16# N+ 4# P2O5

Dry formulations=

N=46-0-0 P=0-46-0 K=0-0-60

5/5/2016	(prior to fertilizing)	Olsen P	NH4O-K	% OM	PH
		3 ppm	94 ppm	3.4	8.2

Table 9.

**2016 Late Wild Oat Applications on Jet Perennial Ryegrass
Rice Farms-Roseau,Mn**

Trt#	Product	Rate	Date	Seed Yield	RCI ¹	lodging ²	Test Wt. ³
				#/acre	At Harvest		
1	Tacoma	10oz.	23-Jun	997	181	6.3	23.7
2	Tacoma	10oz.	29-Jun	1110	170	7.3	23.6
3	No treatment			1151	183	7.7	24.5
LSD 5% level				152	NS	NS	
CV(%)				6	4	9	

Experimental design-RCB with 3 reps

¹-RCI-Relative chlorophyll index-higher number=more chlorophyll

²-Lodging-1=no lodging;9=flat

³-Test wt.-clean seed test weight per bushel

Table 9a.

**2016 Late Wild Oat Applications on Arctic Green Perennial Ryegrass
Magnusson Research farm- Roseau,Mn**

Trt#	Product	Rate	Date	Seed Yield	RCI ¹		Color ²	Test Wt. ³
				#/acre	23-Jun	15-Jul	15-Jul	
1	Assure II	10oz.+ .25%NIS	23-Jun	686	470	242	5.3	24.5
2	Assure II	10oz.+ .25%NIS	28-Jun	735	511	240	5.5	24.0
3	No treatment			898	455	256	5.0	24.7
LSD @5% level				175	NS	NS	NS	
CV(%)				13	15	13	27	

Experimental design-RCB with 4 reps

¹-RCI-Relative chlorophyll index-higher number=more chlorophyll

²-Color- 1=light green;9=dark green

³-Test wt.-clean seed test weight per bushel

Both applications done within 2 hours under similar conditions

Application with 6' backpack sprayer--18gpa

1st application- 6/23/2016 11:00am

Heavy/peak bloom at time of application

2nd application- 6/29/2016 2:00pm

late bloom stage wind SW-10mph--78F

Table 12.

2016 Ryegrass Fungicide Seed Production Trial 2 Northern Minnesota Locations

TRT #	Product	Adjuvant	Rate/ac.	Seed Yield (#/acre)		RCI ¹			Lodging ²		Test Wt. ³		
				Mean	location1	location2	Mean	location1	location2	location1	location2	location1	location2
1	No treatment			1075	1115	1037	170	198	143	6.5	8	25.2	24.6
2	Quilt Xcel 2.2 SE	1%COG	14 oz.	1373	1404	1342	192	216	167	6.8	8	25.8	25.9
3	Absolute 4.36 SC	1%COG	7.5 oz.	1289	1284	1295	187	212	162	6.8	8	25.4	24.8
4	Trivapro SE	1%COG	13.7 oz.	1328	1333	1324	190	212	168	7.3	8	25.6	25.6
5	Trivapro SE	1%COG	17 oz.	1348	1359	1337	199	217	181	6.3	8	25.8	25.6
6	Folicur	.25%NIS	5 oz.	1292	1357	1226	176	195	158	6.3	8	25.2	24.2
7	Prosaro SC	.25%NIS	6.5 oz.	1361	1317	1404	189	212	166	6.5	8	25.6	25.8
8	Approach2.08	.25%NIS	6 oz.	1280	1377	1184	186	210	162	6.8	8	25.8	24.7
9	Approach2.08	.25%NIS	9 oz.	1289	1282	1297	185	210	158	6.0	8	25.6	25.7
10	Priaxor	.25%NIS	6 oz.	1371	1457	1284	199	223	175	6.5	8	25.8	26.1
LSD @5% level				161	174	231	12	13	21	0.9	NS		
cv(%)				8.5	9	12.5	4.2	4.2	9	10	0		

Experimental Design= RCB with 4 reps

Plot size= 10' x30'

Location 1= Pieper farm- Lake of the Woods area- Minnesota

Perennial ryegrass variety= Jet

Harvested 7-20-2016

Fungicide applications-6-28-2016 7:00pm 70F wind SW3-6mph

CO2 backpack sprayer @14GPA

GS= fully headed mid-pollen shedding

Location 2=Rice farms-Roseau area-Minnesota

Perennial ryegrass variety= Royal Green

Harvested 7-25-2016

¹-RCI =Relative Chlorophyll Index --Higher number is higher relative amount of chlorophyll

²-Lodging=1= no lodging; 9=severe lodging

³-Test Wt.=(#/bushel) of treatment composite sample- no replication or analysis

Fungicide applications-6-29-2016 7:00pm 74F wind WSW5-10mph

CO2 backpack sprayer @14GPA

GS= fully headed late pollen shedding

No crop phytotoxicity noted at any stage with any treatment-either location

No crown or stem rust or other diseases noted at either location

Table 13.

**2014-15 Ryegrass Date of Planting
Magnusson Research Farm-Roseau,Mn**

Trt.#	Treatment	Plant date	Seed Yield #/acre			Lodging ⁴	Ht.(in.)	RCI ⁵
			2015	2016	2015-16			
1	Wheat+ryegrass ¹	6/4/2014 6/1/2015	954	1317	1136	7.1	24	203
2	Fallow plant ³	8/20/2014 8/19/2015	469	887	678	6.9	25	223
3	wheat stubble ²	9/8/2014 9/3/2015	776	1524	1150	7.5	25	226
LSD @5% level			240	227	212	NS	NS	NS
CV(%)			19	11	12	8	5	26

Experimental Design: RCB with 4 reps

Variety=Arctic Green Previous crop=soybeans

Ryegrass production used best management practices

¹Trt#1= 5#/ac. Ryegrass + 100# wheat planted late May

²Trt#2=Wheat harvested and 5#/acre ryegrass planted into stubble early September

³Trt#3=5#/acre ryegrass+20#/acre wheat planted into black ground late August

⁴Lodging- 9=flat ; 1=upright

⁵RCI =Relative Chlorophyll Index --Higher number is higher relative amount of chlorophyll

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Table 14.

**2015 Fall Plant- Perennial Ryegrass Residue Management Trial
Magnusson Research Farm-Roseau,Mn**

Trt#	Residue Spring	Seed Yield #/acre	Ht(in.) harv	RCI ¹ 7/27	Lodging ² 7/27	
						1
2	Ryegrass only	none	902	24	133	8
3	Ryegrass+wheat	none	1050	24	219	7
4	Ryegrass+wheat	burn	1038	24	265	8
5	Ryegrass+wheat	mow	1255	24	180	7
LSD @5% level		229	NS	97	1	
CV		11	4	27	8	

Experimental design:RCB with 3 reps

Seeding date - 8/19/2015 Harvested 7-27-2016

¹-RCI =Relative Chlorophyll Index --Higher number is higher relative amount of chlorophyll

²-Lodging=1= no lodging; 9=flat

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

1-Ryegrass only-

2-Ryegrass+Wheat -

3-Ryegrass + Wheat- Clip 5" Oct.13-2015

4-Ryegrass+Wheat- Burned 4-29-2016

5-Ryegrass+Wheat- Clip 4" 5-9-2016

Table 15.

Main effect means for late season traits: seed yield, harvest index (HI), lodging and plant height (PH). Trial years were separated when there was an interaction with treatment. There were no significant effects of plant growth regulator in the ANOVA, therefore it was excluded from means separation.

Treatment	Seed Yield			HI			Lodging			PH		
	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16
	#/acre			%			%			cm		
Burn	1142 a‡	773 a	932 a	29.0 a	21.7 a	18.1 a	17.1 a	32.8 a	45.5 a	47.5 b	59.6 a	57.5 a
Bale	1074 ab	565 b	956 a	28.4 a	22.6 a	15.5 ab	9.4 a	13.0 a	66.0 a	46.1 a	54.8 a	59.6 a
No treatment	879 b	231 c	710 b	27.3 a	14.0 b	13.3 b	5.7 a	0.2 a	67.3 a	44.2 ab	54.4 a	59.7 a
Mean	1032A§	523 C	868 B	28.2 A	19.5 B	15.6 C	10.8 A	15.4 A	59.6 B	45.9 A	56.3 B	58.9 B

‡ Means followed by the same lowercase letter within a column are not statistically different according to Tukey's HSD ($P \leq 0.05$).

§ Means followed by the same upper case letter between trial years are not statistically different according to Tukey's HSD ($P \leq 0.05$).

Best management practices

Action	Product	Rate/acre	Date of application		
			2013-14	2014-15	2015-16
Fertility	Granular (20-10-10)	30 - 15 - 15 lbs.	8/20/13	8/27/14	8/27/15
Pre-emergent weed control	Prowl H2O (pendimethalin)	4 pints	8/20/13	8/27/14	8/27/15
Fertility	Granular urea (46-0-0)	110 - 0 - 0 lbs.	5/29/14	5/13/15	5/3/16
Grassy weed control	Assure II (quizalofop P-ethyl)	10 fluid oz.	6/20/14	6/12/15	6/9/16
Broadleaf weed control	Dicamba + 2,4-D	0.5 pints ea.	6/20/14	5/27/15	6/3/16
PGR lodging control	Apogee (prohexadione ca)	8 mass oz.	6/25/14	6/24/15	6/9/16
Fertility	N-pac liquid	16 fluid oz.	6/25/14	6/24/15	6/9/16
Rust control	Quilt Excel	16 fluid oz.	7/17/14	6/24/15	6/29/16

Fall residue management treatments

Action	Treatment	Rate	Date of treatment application		
			2013-14	2014-15	2015-16
Bale and mow	Cut short and remove straw	NA	8/20/13	8/27/14	8/27/15
Field burn	Paraquat (gramoxone)	1.5 Pt.	8/20/13	8/27/14	8/27/15
	Physical burn	NA	8/29/13	9/7/14	9/18/15

In summary, economically viable second year perennial ryegrass seed production is possible in northern Minnesota using current winter hardy commercial varieties, proven agronomics, and appropriate residue management. In this study, environmental conditions varied greatly across years and a wide range of common soil types were trialed. Over the three trial years extreme minimum soil temperatures ranged from above average to the coldest observed in ten years. Future research should focus on testing fall fertilizer and pre-emergent herbicide application rates and timing to increase yield and maintain seed maintain seed purity over time.

Table 16.

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

Treatment	Rate/Adjuvant	Seed Yield #/ac.	% injury ¹		Lodging ² At Harvest	Ht (in.)	stand ³ 18-Apr
			6-Jun	23-Jun			
1-Section 2	12oz+1%COC	35	80	87	1.0	6	93
2-Fusilade ⁴	10oz.+1%COC	1789	0	0	5.3	27	87
3-Callisto	3oz.+1%COC+2.5%-28%N	1552	12	0	4.7	26	90
4-Clarity	.75pt	1629	0	0	5.0	27	83
5-2,4-D amine	.75pt	1451	0	0	5.7	27	93
6-2,4-D+Clarity	.75pt+.75pt.	1341	0	0	4.7	25	90
7-UTC		1439	0	0	4.0	27	93
	LSD @5% level	393	2	4	2.0	2	NS
	CV(%)	16	8	17	28	5	15

Experimental Design:RCB with 3 reps

¹%injury- Visual %rating of grass/seed head suppression.

²lodging-1=no lodging; 9= flat

³stand-visual rating prior to herbicide application

⁴ Fusilade had good sloughgrass and foxtail barley control

Stand- visual notes taken prior to herbicide application

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

Fertility application- 60-40-40 10/25/2015

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

Table 17.

2016 Spring Wheat Growth Regulator with Underseeded Ryegrass Trial**Magnusson Research Farm-Roseau,Mn**

Variety='Prosper' Seeding rate= 125#/ac.

Ryegrass variety= Arctic Green-- seeding rate=6#/ac.

Trt#	Application		Added N	Yield ² Bu./ac @ 12% moisture	Dry ³			Heading date-July	Ht.(in) at harvest	RCI ⁴	
	Palisade(2EC) oz./ac.	Growth Stage(Feeks)			Fertility ¹	T/ac.	Test wt			Protein	6/23
1	No treatment		120	70.3	5.2	61.3	12.8	7	37.0	375	555
2	3.5	5	120	66.9	4.5	61.2	12.9	8	36.3	354	507
3	3.5	7	120	67.2	4.7	61.7	13.4	8	36.0	367	503
4	5.3	5	120	59.2	4.3	61.3	13.2	10	32.5	346	504
5	5.3	7	120	66.7	4.5	61.3	13.0	8	35.8	356	550
6	7.2	5	120	62.7	4.4	61.2	13.5	10	31.7	337	465
7	7.2	7	120	65.6	4.5	61.4	13.4	9	33.5	389	523
8	No treatment		155	73.0	5.4	61.0	14.5	8	37.0	364	607
9	3.5	5	155	69.5	5.2	61.3	14.5	10	35.7	323	587
10	3.5	7	155	72.9	4.5	61.3	14.6	8	36.8	369	611
11	5.3	5	155	68.8	4.9	60.8	14.8	11	34.5	383	512
12	5.3	7	155	68.8	5.1	61.2	14.5	9	35.3	341	497
13	7.2	5	155	68.7	4.3	61.0	14.7	11	32.8	346	537
14	7.2	7	155	68.1	5.0	61.7	14.3	9	33.5	359	503
LSD @5% level				4.5	0.6	0.4	0.9	1	2	53	76
CV(%)				4.7	10.5	0.5	4.7	8	4.8	10.3	10

Experimental design: RCB with 4 reps

Plot size= 6' x 15'

Seeded 5-11-2016

No lodging observed on any plots

RCI- 7/27= clear sky 5:00pm

Previous crop= 2015- soybeans

6/23= full sun 2:30pm 5leaf 2tiller

Added N= +35N urea +Agrotain at 4 leaf

All Palisade treatments receive .25%NIS

Palisade EC rates= UTC, 7 ,10.5 ,& 14oz.

(Palisade 2EC- 3.5,5.3,7.2)

Nitrogen fertility applications=120#/ac.- Hi Rate=150#/ac.

Management- apply 120-40-40-20s to entire field 5/2016

¹6/3/2016 -Applied 35-0-0(urea+Agrotain) @ 3 leaf to----

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² Yields corrected to 12% moisture³ Dry matter is total straw and seed biomass cut at 3".⁴RCI - Relative chlorophyll index- Higher number = more chlorophyll

1pt. Bronate 6/21/2016

1st Palisade treatment 6/21/2016(Feeks 4)

2nd Palisade treatment 7/2/2016 (Feeks 8)

Folicur @ 3oz. Applied 7/15/2016

Soil test prior to fertilization 5/5/2016

Olsen

0-24"

P2O5-ppm

K2O-ppm

NO3- #/ac

8

192

41#

Table 19.

**2015 and 2016 Intermediate Wheatgrass Grain Yields
Roosevelt, MN and Roseau, MN**

Location	Grain Yields (lb/A)	
	<i>Year 1</i>	<i>Year 2</i>
Roosevelt	570	125
Roseau	710	230

Preliminary small plot yields of intermediate wheatgrass at 2 locations.

Means of 5 row spacings and 2 seeding rates at 2 locations.

Estling farm-north of Roosevelt

Magnusson Research farm-Northwest of Roseau

Data collected by Jacob Jungers and Brett Heim