

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:

<https://turf.umn.edu/seed-production-research-progress-reports>

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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-BMP(best management practice)

Ryegrass seeded at 5#/acre with spring wheat
Sterling Blue(dicamba)+ 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
Tacoma or Assure II (8-10 oz) applied early June, 800 - 1,000 GDD
Apogee (6-8 oz) applied early heading, 1,100 - 1,300 GDD
Priaxor 6oz. applied full heading, 1,700 - 1,900 GDD

Fall seeded ryegrass in wheat stubble

Pre-harvest glyphosate application to wheat , or
glyphosate applied to wheat stubble prior to seeding ryegrass.
Ryegrass seeded at 6#/acre after wheat harvest into existing stubble
No broadleaf application in fall but other management for fall seeded ryegrass the same as spring seeded.
If planted into summer fallow, no additional nitrogen is added.

Tall Fescue

Establishment=Seed at 7#/acre under spring wheat in May.
60-50-50-10s September after wheat harvest and 80-0-0 early May.
.75pt. 2,4-D a + .75pt. Sterling Blue late September.
Bale off straw after harvest and clip 4"+ bale remaining residue in mid September.

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, quality and other data are statistically analyzed and results summarized.

On-farm small plot research trials

General crop management is 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 1967-2020.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly Total(in.)	Mean Deviation	Mean(F ^o) 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	-3.52	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	7.25	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	1.63	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	2.60	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	-4.36	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	-3.58	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	-1.26	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	3.79	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	-4.63	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	-6.85	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	-3.24	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	-2.06	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	-5.22	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	-3.53	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	0.92	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	-2.47	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	-0.73	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	-5.25	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	2.37	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	-3.30	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	-4.76	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	-5.75	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	-0.97	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	-11.00	38.2
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	7.61	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	-2.06	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	-0.89	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	-4.08	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	-0.73	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	3.31	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	-2.01	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	2.26	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	0.21	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	5.55	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	-3.89	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	3.14	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	1.79	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	11.45	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	8.61	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	-6.19	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	2.62	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	3.84	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	3.88	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	5.23	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	-4.96	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	-3.58	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	1.39	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	3.06	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	8.47	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	1.39	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	0.48	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	-4.53	36.6
2019	0.90	1.65	1.66	0.27	1.42	2.99	4.09	3.42	9.95	4.18	0.80	0.74	32.07	9.39	35.2
2020	0.84	0.29	1.30	0.53	1.66	6.29	8.23	2.30	0.77	1.11	1.19	0.99	25.50	2.82	38.3

51 year average annual precipitation 22.68

50 year available mean temperature= 37.3

*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 20 years=25.04". Average precipitation the previous 33 years=21.16"

Mean temperature 1967-1990 =36.1 & 1991-2020 = 38.1

Table 2.

**2019 Perennial Ryegrass Seed Production Variety trial
Magnusson Research Farm-Roseau,Mn**

Company	Entry	Seed Lot#	Seed Yield(#/acre)		Seed Yield as % of Mean		Ht.(in.)	Harvest		Heading (%)						
			2020	2019 ¹	2yr.ave	2020		2019 ¹	Lodging ²	Date	6/3	6/8	6/12	6/17	6/22	6/26
U of M	Arctic Green	4113	1364	1347	121	107	134	21	2.3	24-Jul	T	5	19	50	70	85
U of M	Spreader IIIxArctic Green	4051	1386	1233	116	109	123	19	1.0	24-Jul	0	T	11	45	65	82
U of M	Green EmperorxArctic Green	4020	1384	1240	116	108	124	20	1.0	23-Jul	0	7	20	53	78	100
U of M	Galactic Green(3999)	4050	1286	1262	114	101	126	20	1.0	26-Jul	0	4	12	35	55	78
Mountain view seed	Grandslam GLD	4084	1420	1145	113	111	114	20	1.5	23-Jul	T	13	30	58	83	91
U of M	Green Emperor	3976	1426	1060	109	112	106	20	2.0	23-Jul	T	9	29	58	78	96
Pure Seed Testing	Silver Sport	4091	1310	1130	108	103	113	21	1.5	22-Jul	3	13	43	65	83	92
Mountain view seed	Fastball RGL	4098	1291	1136	107	101	113	18	1.3	23-Jul	0	7	25	50	68	91
DLF-N.excel	Thrive	4099	1279	1019	101	100	102	20	1.5	23-Jul	2	13	26	63	80	100
Pure Seed Testing	Gray Fox	4087	1259	977	99	99	98	22	2.8	23-Jul	2	19	45	73	90	93
Pure Seed Testing	Silver Sun	4110	1130	907	90	88	91	20	1.5	22-Jul	6	30	61	78	93	97
check	NK-200	3917	1130	810	84	88	81	25	2.3	27-Jul	0	3	8	28	48	81
U of M	Forage-2018	4100	1017	731	77	80	73	21	1.0	25-Jul	0	3	15	40	73	92
Pure Seed Testing	New Sealand	4111	1366	----	----	107	NA	19	1.8	22-Jul	3	24	48	67	85	97
U of M	EPR-18(early line)	4103	1264	----	----	99	NA	24	2.8	27-Jul	0	0	T	10	28	76
Pure Seed Testing	Gray Hawk	4112	1124	----	----	88	NA	18	1.0	23-Jul	4	16	45	65	80	93
LSD @5% level			135	105	9	10	10	3	NS	1	2	7	13	15	16	13
CV(%)			7	7	8	7	7	9								
Seed Production trial mean			1277	1003												

Experimental design:RCB with 4 reps

Planted in 6" rows with Hege plot seeder with double disk openers @7#/acre with Linkert spring wheat @ 120#/acre on 5/31/2019

¹-2019 seed yields are from a variety trial seeded in 2018. NA varieties not planted in 2019

²-Lodging; 1=upright; 9=flat

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Table 3.

**2019 Fine Fescue Seed Production Variety trial
Magnusson Research Farm-Roseau,Mn**

Species	Variety	Seed Lot#	Yield #/acre	Harvest Ht.(in.)	Lodging ¹	Harvest Date	Heading (%)				
							5/26	5/30	6/4	6/8	6/12
hard fescue	MN-HD	4065	906	26	1	1-Jul	25	55	80	97	100
hard fescue	SPHD	2	765	25	1	1-Jul	25	55	85	96	100
hard fescue	Beacon	3	699	27	1	1-Jul	28	53	80	96	93
hard fescue	Gladiator	4	579	26	1	1-Jul	20	53	83	97	98
hard fescue	Jetty	5	681	28	1	1-Jul	28	55	80	96	100
chewing	Radar	6	661	33	1	6-Jul	1	15	50	86	98
strong creeping	Chantilly	7	402	28	1	6-Jul	0	5	38	63	84
LSD @ 5% level			102	2	0	0	6	9	10	7	3
CV(%)			10	5							

Experimental design:RCB with 4 reps

Planted 5/10/2019 in 6" rows with Hege plot seeder @6#/acre

¹-Lodging; 1=upright; 9=flat

Table 4.

2019 Perennial Ryegrass Winter Hardiness Trial
Magnusson Research Farm Roseau, Mn & U of Minn. St. Paul Campus

Variety/Line	Seed lot	Winter Injury ¹				Mean	St. Paul 4/6/2020
		Roseau					
		11-May	16-May	23-May			
Green EmperorxArctic Green	4031	5.0	4.0	2.0	3.7	1.0	
Green Emperor	3976	7.0	5.5	3.8	5.4	1.0	
Gulf-annual	3983	9.0	9.0	9.0	9.0	3.3	
MSPxA.Green/R.Green 3999	4050	6.0	4.8	3.0	4.6	1.0	
NK-200	3917	7.0	6.3	4.3	5.8	1.0	
Accent II	4096	8.3	7.6	5.8	7.2	1.0	
Forageur	4043	5.3	4.5	3.0	4.3	1.0	
Arctic Green	4113	6.5	5.3	4.3	5.3	1.0	
Spreader IIIxArctic Green	4051	4.5	4.0	2.8	3.8	1.0	
Forage sel-2019	4116	4.3	4.8	3.8	4.3	1.0	
EPR18(early per.ryeg)	4103	4.0	3.3	2.3	3.2	1.0	
Forage sel-2018	4100	5.8	5.3	3.5	4.8	1.0	
Forage 1/2 sib-2017	4066	6.0	5.0	3.0	4.7	1.3	
Spreader 1/2 sib-2017	4067	4.3	3.5	1.5	3.0	1.8	
LSD @5% level		2.1	2.3	2.6	2.2	0.5	

Experimental design:RCB with 4 reps

Single row plots planted-

Roseau = 9/4/2019 St.Paul =9/9/2019

¹-Winter injury- 1= no injury; 9=dead.

Table 7.

2020 Faba bean and Field Pea Variety Trial Magnusson Research Farm

Field Peas	Bushels/acre¹		First Flower
	2020	2019	Date
Orchestra	25.4	NA	2-Jul
PO 937-4006	17.7	NA	2-Jul
AAC Asher	25.5	111	2-Jul
Cronos	17.7	NA	30-Jun
AAC Profit	36.2	108	4-Jul
Spider	24.5	96	3-Jul
Navarro	11.6	NA	28-Jun
Salamanca	36.6	96	2-Jul
LSD @ 5% Level	14	11	1
CV(%)	34	7	2

Faba Beans:	Bushels/acre¹		First Flower
	2020	2019	Date
Tiffany	NH	NA	4-Jul
Fabelle	NH	73	2-Jul
Stella	NH	NA	2-Jul
Victus	NH	NA	2-Jul
Boxer	NH	68	2-Jul
LSD 5%	NA	NS	NS
CV(%)	NA	11	4

Experimental Design: RCB w/3 reps

Yield¹=Bushels per acre at 12% moisture and 60#/bushel

Faba beans not harvested because of water damage and disease caused by excessive rainfall.

Herbicide application- Authority Elite 1.5pt.acre applied immediately after planting in 2019-20.

Site= Conventional tillage seedbed- Non-irrigated

Fertility application 10-40-40 Soil type- sandy loam

Previous crop- spring wheat

Planting Date= 5/19/2020

Harvest date-Peas=8/24/2020, 8/30/2019 ; Faba beans =not harvested

Faba bean Seeding Rate= 197,000PLS/acre

Field pea Seeding Rate= 350,000PLS/acre

Table 8a.

2019-20 Perennial Ryegrass Fertility Trial
Magnusson Research Farm-Roseau,Mn

Trt#	Total Fertilizer	Application ¹ Timing	Seed Yield ²		Harvest		RCI ³ 6/12
			#/acre	% mean	Date	Ht(in.)	
1	0	No fertilizer	384	24	23-Jul	14	169
2	140+50+50	30-50-50 fall+110-0-0 spring	1606	101	23-Jul	21	487
3	140+90+50	30-50-50 fall+110-40-0 spring	1526	96	24-Jul	20	505
4	140+50+50	10-50-50 fall+130-0-0 spring	1647	104	23-Jul	21	508
5	100+50+50	30-50-50 fall+70-0-0 spring	1578	99	23-Jul	20	441
6	140+50+50+20s	30-50-50-20s fall+110-0-0 spring	1497	95	23-Jul	20	531
7	140+50+50+70s	30-50-50-70s fall+110-0-0 spring	1562	99	25-Jul	21	468
8	140+50+50	140-50-50 spring	1666	105	26-Jul	20	465
9	140+50+50	30-50-50 fall+110-0-0-20s spring	1618	102	25-Jul	21	584
10	140+50+50	30-50-50 fall+70-0-0 spring+40liquid	1555	98	24-Jul	20	463
LSD @5% level			165	10	2	2	96
CV(%)			8	8	6	6	15

Experimental Design:RCB w/4reps

Variety=Arctic Green

Perennial ryegrass spring seeded 5/2019 under wheat.

¹-Treatment explanations below²-Seed Yield- Clean seed yield of each treatment in LBS/Acre and % of trial mean(not including no added N trt#1)³-RCI-Relative Chlorophyll Index-higher value=more chlorophyll

Mean yield(not including 0# N)= 1584#/ac

10/19/2020 Soil test results

Depth	Olsen P	K	% OM	PH	NO3-N
0-6"	7 ppm	104 ppm	2.6	8	4 ppm
6-24"					9 ppm

Trt#	Season	Treatment applications and timing ¹	Treatment Explanation-*
1	0	No added fertilizer	No fertilizer - check
2	140	30-50-50 fall+110-0-0 Spring	Recommended standard split
3	140	30-50-50 fall+110-40-0 Spring	Recommended standard+0-40-0 with spring N
4	140	10-50-50 fall+130-0-0 spring	All N applied in spring
5	100	30-50-50 fall+70-0-0 spring	Recommended split-100#N only
6	140	30-50-50-20s fall+110-0-0 spring	Standard+90# AMS(19-0-0-20s) in fall
7	140	30-50-50-70s fall+110-0-0 spring	Standard+290# AMS(60-0-0-70s) in fall
8	140	140-50-50 spring	All fertilizer spring applied
9	140	30-50-50 fall+110-0-0-20s spring	Standard+ 90# AMS in spring
10	140	30-50-50 fall+70-0-0 spring+13 gallon 28%N 6/17	100#N dry urea+40#N flat fan spray 28%N

Fall applications- 10/23/2019

Spring applications-5/11/2020

Liquid application -6/17/2020

*-Standard application= 30#N in October and remainder in early May.

Table 8b.

2011-20 Perennial Ryegrass Fertility Trial Seed Yield Summaries
Magnusson Research Farm-Roseau,Mn

Trt. #	Nitrogen Fertilizer	Nitrogen Timing	Overall Mean	Seed Yield as % of Mean									
				2020	2019	2018	2017	2016	2015	2014	2013	2012	2011
1	0	0	29	24	20	21	45	38	29	27	28	21	36
2	100+0+0	Split ¹	99	99	103	90	104	90	----	92	96	112	108
3	140+0+0	Split ¹	107	104	111	101	99	110	99	104	104	118	118
4	140+40+0	Split ¹ +(0-40-0spring)	110	96	100	107	106	109	127	120	----	----	----
5	140+0+0+20s	Split ²	101	95	99	101	102	----	----	110	99	----	----
6	140+0+0	Split ¹ +(90spring+20liq)	103	98	102	101	99	----	----	106	109	----	----
7	180+0+0	Split ¹	109	----	----	107	92	111	----	122	111	----	----
8	140+0+0+20s	Split ³	102	102	102	----	----	----	----	----	----	----	----
LSD @5% level				10	13	11	13	12	20	11	16	11	12
CV(%)				8	10	8	9	9	16	8			

Experimental Design:RCB with 4 reps

Variety all years=Arctic Green

Yield Trial mean by year (#/acre)--

1584 1668 1631 1627 1220 1344 1244 1068 1499 1313

¹-Split-30-40-40 applied fall and remainder in spring(increased to 30-50-50 in 2019)

²-Split-30-50-50-20s(77#AMS / acre) applied in fall+110-0-0 in early May

³-Split-30-50-50 applied fall+110-0-0-20s (77#AMS / acre) in early May

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
- 8 30-40-40 applied Sept.-Oct. / 110-0-0-20s applied early May

Observations/Conclusions- from past fertility trials

Applying 10-20% of spring nitrogen as ESN has been beneficial in some years.

Best of the treatments listed over years was #4 but may be of less advantage with medium or high soil levels of phosphorous.

Nitrogen rates over 140#/ac. May improve yields slightly but may not be economical and can cause lodging and harvest issues.

Table 9.

2020 Perennial Ryegrass Herbicide/Management Trial
Magnusson Research Farm-Spring Plant¹

Trt#	Herbicide Treatment	Rate	Management Level ²	Seed Yield #/acre	Test wt./ Bushel	Harvest	
						Ht.(in.)	Lodging ³
1	Quelex+WideMatch+.25%NIS/Tacoma	.75oz+1pt/10oz	BMP	1370	23.6	21	3.0
2	Callisto+Sterling Blue+2,4-D/Tacoma	3oz+12oz+12oz/10oz	BMP	1546	23.1	21	4.0
3	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP -	1506	23.3	23	3.3
4	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP	1412	22.2	23	5.0
5	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP +	1541	22.7	22	4.7
6	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP ++	1356	22.6	22	7.0
7	Wolverine Advance+Amsol	1.7pt +1pt.	BMP	1359	23.1	22	4.0
8	Facet+2,4-D+Sterling Blue	1.5pt+12oz+12oz	BMP	1362	22.7	22	4.0
9	Sterling Blue+2,4-D+Prowl H2O/Tacoma	12oz+12oz+3.5pt/10oz	BMP	1394	22.3	21	2.3
10	No Treatment		BMP	1263	22.9	21	2.7
LSD @5%level				138	1.1	NS	2.1
CV(%)				5	3	6	31

Experimental design:RCB with 3 reps

¹-No fall herbicide applied

²-Management level- Not including herbicide application

BMP = (Best management practice) 6oz. Apogee+3 Gal. 28%N +low cost fungicide / premium fungicide + 3gal 28%N 3 weeks before harvest

BMP - = BMP substitute no fungicide with Apogee / substitute low cost fungicide only 3 weeks before harvest

BMP + =growth regulator + premium fungicide + insecticide1X

BMP ++ =growth regulator + premium fungicide + insecticide 2X

Trt# Treatment and Date

- 1-- Quelex+WideMatch 5-30 / Tacoma 6-12/ Apogee + Tilt+ 3 gal 28%N 6-15 / Priaxor 6-20+3 gal 28%N 6-20
 2-- Callisto+ 2,4-D+ Sterling Blue 5-30/ Tacoma 6-12/ Apogee + Tilt+ 3 gal 28%N 6-15 / Priaxor 6-20+3 gal 28%N 6-20
 3-- 2,4-D+ Sterling Blue 5-30/ Tacoma 6-12/ Apogee + 3gal 28%N 6-15 / Folicur 6-20
4-- 2,4-D+ Sterling Blue 5-30/ Tacoma 6-12/ Apogee + Tilt+ 3gal 28%N 6-15 / Priaxor 6-20+3gal 28%N 6-20(standard BMP)
 5-- 2,4-D+ Sterling Blue 5-30/ Tacoma + 3gal 28%N +Folicur 6-12/ Apogee + Quilt+ Warrior+3gal 28%N 6-15 / Priaxor 6-20+3gal 28%N 6-20
 6-- 2,4-D+ Sterling Blue 5-30/ Tacoma + 3gal 28%N +Folicur 6-12/ Apogee + Quilt+ Warrior +3gal 28%N 6-15 / Priaxor 6-20+Warrior+3gal 28%N 6-20
 7-- 2,4-D+ Sterling Blue 5-30/ Tacoma +3 gal 28%N +Folicur 6-12/ Apogee + Quilt +3gal 28%N 6-15 / Priaxor 6-20+3gal 28%N 6-20
 8-- Wolverine 6-12/ Apogee + Tilt + 3gal 28%N 6-15 / Priaxor 6-20 + 3gal 28%N 6-20
 9-- 2,4-D+ Sterling Blue+Prowl H2O 5-30/ Tacoma 6-12/ Apogee + Tilt+ 3 gal 28%N 6-15 / Priaxor 6-20+3 gal 28%N 6-20
 10-- NO HERBICIDE--Apogee + Tilt+ 3 gal 28%N 6-15 / Priaxor 6-20+3 gal 28%N 6-20

Trade Name	Common name -Active ingredient/gallon(or % dry)	Use Rate/acre
Quelex	10% halauxifen+10% florasulum	.75oz
WideMatch	.75#CLOPYRALID + .75#FLUROXYPYR	1pt
Tacoma(Puma/Parady)	1#FENOXAPROP-P-ETHYL	10oz
Callisto	4# mesotrione	3oz
Sterling Blue	4# Dicamba	.75pt
2,4-D	4# 2,4-D amine	.75pt
Wolverine Advance	.4#FENOXAPROP-P-ETHYL + .13#PYRASULFOTOLE +1.05# BROMOXYNIL	1.7pt
Prowl H2O	3.8#Pendimethalin	3.5pt
Apogee	27.5% PROHEXADIONE CALCIUM	8oz
Preference	Non-ionic surfactant(90%NIS)	1qt./100gallons water
Amsol	1gallon=3.4# dry AMS =.7#N/gal	1 pt
28%N	2.9#N(UAN)/Gal	3 gal
Tilt	3.6#Propiconazole	4 oz
Quilt Xcel	1.02#PROPICONAZOLE + 1.18#AZOXYSTROBIN	12oz
Priaxor	1.39#FLUXAPYROXAD +2.78# PYRACLOSTROBIN	6oz
Warrior(Grizzly)	2.08#LAMBDAHALOTHHRIN	1.5oz
Folicur	3.6#Tebuconazole	4oz

Observations/Conclusions-

Best Management Practice(BMP)- Subject to change based on crop condition, soil type, product pricing and many other factors.

Trt#2- Callisto has shown some chlorosis and shortening but also occasionally an increase in seed yield.

Possible changes to BMP?- 1) use 2.5%N solution(about .3gal/acre instead of 3 gal./acre)

2) Apply Grizzly with premium fungicide in trt #5 instead of with growth regulator

Table 10.

**2019 Herbicides Applied to Linkert Spring Wheat
with Underseeded Arctic Green - Perennial Ryegrass
Magnusson Research Farm-Roseau,Mn**

trt#	Treatment	Rate/adjuvant	Seed Yield(#/acre) ¹		% Stand ²	Vigor ³
			standard	short-clip		
1	No treatment		1431	NH	65	5.3
2	Wolverine Advance	1.7pt + 1pt Amsol	1486	NH	70	5.8
3	Bison + Tacoma	1pt + 10oz.	1513	1606	78	5.3
4	Bison	1pt.	1531	NH	70	5.0
5	Affinity tank mix+MCPE+Tacoma	.8oz +.5pt +.25%NIS	1366	NH	58	4.5
6	Everest 2.0 +MCPE	.75oz+.5pt +.25%NIS	1382	NH	60	4.5
7	Talinor+Tacoma	16oz +10oz + 3.2oz. CoAct	1393	NH	68	5.0
8	Hat Trick + Tacoma	1.5pt+10oz +.25%NIS	1406	NH	70	5.8
9	Quelex+MCPE+Tacoma	.75oz +1pt + 10oz +.25%NIS	1509	NH	70	5.8
10	Quelex+WideMatch+Tacoma	.75oz+1pt + 10oz+.25%NIS	1471	1713	68	4.5
LSD @ 5% Level			NS	NS	9	1.2
CV(%)			10	2	9	15

Experimental design:RCB with 4 reps

¹-Ryegrass yield-2020= straw and residue left at 7" after fall wheat harvest.

¹-Short clip=wheat straw clipped to 3"and raked off 5/5/2020. Ryegrass in treatments 3&10 only harvested in clipped area.

²-Ryegrass stand POST Harvest-1=no plants; 9=full stand

³-Ryegrass fall vigor- 1=least ; 9=best

Wheat with underseeded ryegrass-

Applications made 6/13/2019 4:30pm 73F SW 10-15 34%RH 20% sunny wheat 4lf , 1-2 tillers. Ryegrass just emerging.

Ryegrass applications in 2020 all done uniformly as per best management practices.

<u>Trade name</u>	<u>Formulation</u>
MCPE	MCPE 3.7#
Talinor	bicyclopyrone .31# + bromoxynil 1.46#
Everest 2.0	flucarbazone .027#
Affinity tank mix	thifensulfuron 40%+tribenuron 10%
Tacoma(Puma)	fenoxypop 1#
Bison(Bronate)	bromoxinil 2# mcpa 2#
Wolverine Advance	fenoxypop .4#,pyrasulfotole .13#, bromoxynil .52#
HatTrick	mcpa 1.8#,fluroxypry .51#,clopypyalid .51#
Quelex	halauxifen .1#+florasulum .1#
Wide Match	clopypyalid .75# +fluroxypry .75#

Observations/Conclusions

Affinity and Everest had negative impact on underseeded ryegrass establishment.

Table 11.

**2020 Perennial Ryegrass Fungicide Management Trial
Magnusson Research Farm-Roseau,Mn**

Trt#	Treatment	Application Date ³	Seed Yield		Test Weight ¹	Harvest	
			#/acre	% of mean		Ht(in.)	Lodging ²
1	Quilt Xcel	30-Jun	1566	100.4	25.2	21	1.0
2	Priaxor	30-Jun	1566	100.4	25.1	21	1.0
3	Folicur	30-Jun	1433	91.9	25.0	21	1.0
4	Badge	30-Jun	1504	96.5	24.3	20	1.0
5	Folicur/Priaxor	6/21+6/30	1535	98.5	25.8	21	1.0
6	Folicur/Priaxor+ Grizzly Z	6/21+6/30	1522	97.6	25.4	21	1.0
7	Folicur+N/Priaxor+ Grizzly Z	6/21+6/30	1758	112.8	25.9	21	1.0
8*	Folicur+N/Priaxor+N+ Grizzly Z	6/21+6/30	1638	105.1	26.3	20	1.5
9	Revytek	30-Jun	1678	107.6	25.1	21	1.0
10	No treatment	NONE	1393	89.4	25.1	22	1.0
LSD @ 5% Level			333	21.3	0.8	2	NS
CV(%)			9	9	2	4	21

Experimental Design:RCB with 3 reps(Only 2 harvested because of wet conditions)

Trial Mean-#/acre 1559

¹-Test weight per bushel of cleaned seed adjusted to 12%moisture. Higher test weight maybe higher quality seed?

²-Lodging-1=Erect; 9=Flat

³-First application date(if applicable) 6/21--Ryegrass 17" height and 50% heading. 9:30pm 82F wind 6-9WNW
Second/main application date-6/30/2020 --Ryegrass 18" height and fully headed. 9:00PM 75F 82%RH wind 6-10SE

* Trt#8 on 6/30 had spray mix problem with product mix coagulating and not remaining in suspension.

Trade			
Trt#	Name	Formulation(# AI/gallon)	Rate per acre+adjuvant
1	Quilt Xcel	1.02#PROPICONAZOLE + 1.18#AZOXYSTROBIN	12oz+1Qt Preference/100gal.
2	Priaxor	1.39#FLUXAPYROXAD +2.78# PYRACLOSTROBIN	6oz.+1Qt Preference/100gal.
3	Folicur	Tebuconazole 3.6#	5oz.+1Qt. Preference/100gal.
4	Badge SC	COPPER HYDROXIDE + COPPER OXYCHLORIDE(2.27#copper)	16oz.
5	Folicur/Priaxor		5oz/6oz.6-20/6-30
6	Folicur/Priaxor+ Grizzly Z (1# LAMBDA-CYHALOTHRIN)		5oz/6oz.+3oz.6-20/6-30
7	Folicur+28%N/Priaxor+ Grizzly Z		5oz+3gal-28%/6oz.+3oz.6-20/6-30
8*	Folicur+28%N/Priaxor+28%N+ Grizzly Z		5oz+3gal-28%/6oz.+3oz.+285N6-20/6-30
9	Revytek	1.11#MEFENTRIFLUCONAZOLE + 1.48#PYRACLOSTROBIN+.74#FLUXAPYROXAD	8oz+1Qt Preference/100gal.
10	No treatment		

Table 12.

2016-20 Ryegrass Fungicide Yield Summary
2 Locations Per Year -Roseau and Lake of the Woods

Product	Adjuvant	Rate/ac.	% of Mean					
			2016-20*	2020	2019	2018	2017	2016
No treatment			89	89	92	93	89	83
Priaxor	.25%NIS	6oz.	104	101	108	103	104	106
Folicur	.25%NIS	5 oz.	97	92	97	97	96	99
Quilt Xcel 2.2 SE	1%COG	14 oz.	103	101	102	101	103	106
Quilt Xcel 2.2 SE+Warrior	1%COG	14oz+2oz	102	----	----	97	106	----
Tilt(PropiMax)	.25%NIS	4oz.	100	----	----	100	99	----
Prosaro SC	.25%NIS	6.5 oz.	106	----	----	107	----	105
Absolute 4.36 SC	1%COG	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	----
	LSD @5% level		NA	21	8	9	8	12
	CV(%)		NA	9	7	7	5	8

2020 Mean Yield= 1559 #/acre

2019 Mean Yield= 1553 #/acre

2018 Mean Yield= 1387 #/acre

2017 Mean Yield= 1675 #/acre

2016 Mean Yield= 1301 #/acre

* Mean of available treatments for at least 2 years.

Observations/Conclusions

Over the last 4 years at 7 locations, Priaxor was the highest yielding labeled product in the trial.

Different active ingredient fungicide products should be used to slow disease resistance.

Table 13.

**2020 Growth Regulator Treatments Applied to Arctic Green Perennial Ryegrass
Magnusson Research Farm-Roseau,Mn**

Trt#	Treatment	Rate/ Acre	Adjuvant/Additive	Seed Yield		Test Weight ¹	Harvest	
				#/acre	% of mean		Ht(in.)	Lodging ²
1	No treatment			1370	83	23.8	26	8.0
2	Palisade EC	.75pt	.25%NIS	1771	107	25.5	25	4.5
3	Palisade EC	1.5pt	.25%NIS	1424	86	25.3	21	1.0
4	Apogee	4oz.	.25%NIS+3gal.UAN	1802	109	25.1	22	2.0
5	Apogee	6oz	.25%NIS+3gal.UAN	1558	95	24.8	22	1.0
6	Apogee	8oz.	.25%NIS+3gal UAN	1709	104	24.5	19	1.0
7	Apogee	8oz.	.25%NIS+0.3 gal UAN	1829	111	25.2	19	1.5
8	Apogee	8oz.	.25%NIS+3gal.AMS	1722	104	24.9	20	1.5
LSD @ 5% Level				362	22	NS	3	0.9
CV(%)				9	9	4	6	14

Experimental Design:RCB with 3 reps(Only 2 harvested because of wet conditions)

Trial Mean-#/acre 1648

¹-Test weight per bushel of cleaned seed adjusted to 12%moisture.

Higher test weight could mean higher quality seed.

²-Lodging-1=Erect;9=Flat

6-13-2020 9pm ryegrass 10-16" tall boot-50%hdng variable stand

62F 54%RH SE 5-10mph

Observations/Conclusions

With plant stands variable and only 2 replications harvested, results should be viewed with caution.

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Table 14.

**2018-20 Spring Stubble Clipping Management on Ryegrass Seed Production
Rice Farms 2018 and
Magnusson Research Farm-2019 and 2020**

Trt#	Clip Treatment ¹	Seed Yield-#/acre		
		2020	2019	2018- ²
1	Clip only	1475	1497	NA
2	Clip-Rake off	1537	1611	1610
3	No Treatment	1395	1386	1430
LSD @ 5% Level		NS	197	63
CV(%)		8	7	2

Experimental Design:RCB w/4reps

Varieties= Rice farm- 'Evolution'

Magnusson Research farm-'Arctic Green'

¹-Clip and leave or clip and remove 5/3 or 5/4

Wheat stubble= 7". Clip height=3"

²-No clip treatment in 2018 from Rice Farms location

Observations/Conclusions

Early spring clipping and straw removal trended to improve seed yield.

Early spring clipping only may also have some yield benefit.

Table 15.

2020 Bicyclopyrone applied to 'Clair' Timothy
David Jones-Gatzke, Mn

Trt#	Treatment ¹	Rate	#/acre	%stand		% Crop supression*			% Weed control		
				22-May	17-Jun	17-Jun	2-Jul	22-Jul	17-Jun	2-Jul	22-Jul
1	Untreated		431	69	33	0.0	20	18	0	0	5
2	A 16003€	3.42 oz	494	75	33	0.0	10	8	75	83	75
3	A 16003€	6.84 oz	538	76	33	0.0	13	9	91	99	95
4	Moxy 2EC	16 oz	514	74	33	0.0	18	13	76	45	75
5	A 16003€ + Moxy	3.42 +16 oz	496	73	32	7.5	15	15	95	90	98
6	Starane Ultra 2.8EC	4.81 oz	514	75	33	0.0	18	10	55	58	55
7	A 16003€ + Starane	3.42+4.81 oz	505	80	33	0.0	3	8	85	88	93
8	Huskie 2.06EC	14.9 oz	552	78	33	0.0	5	8	78	94	85
	LSD @ 5% Level		NS	NS	NS	1.5	13	NS	16	20	18
	LSD @ 10% Level		105	13	1	1.2	11	9	13	17	15
	CV(%)		17	14	3	108	72	70	16	20	17

Experimental Design:RCB with 4 reps

¹-All herbicide treatment had 1qt./100 gallons Preference(NIS) added to mix.

*Crop supression could be either from herbicide or weed competition.

Applications made 5/22/2020 1:30 PM

wind SSW 4-7mph 68F 60%RH cldy

vegetation and soil dry at application

Crop -G stage= late vegetative 9" ht.--Weed growth stage- 2-3"

Plot size= 10' x 25'

Sprayer- CO2 bike sprayer 20" nozzel spacing

nozzel type= 8002 TT @27PSI

Predominate weeds present=

dragonhead mint

blackseed plantain

wild mustard

milkweed

dandelion

mustard ssp.

A 16003€-- 1.67# bicyclone

Moxy 2EC-2# bromoxynil

Talinor- .31# bicyclopyrone + 1.46# bromoxynil

Starane Ultra- 2.8# FLUROXYPYR

Huskie - 1.75#BROMOXYNIL + .31#PYRASULFOTOLE

Table 17.

**2019 Fall Herbicide Applications to MN-HD hard fescue
Magnusson Research Farm-Roseau,Mn**

Herbicide Treatment	Rate/acre	Harvest Ht(in.)	Seed Yield(#/acre) ³	
			Estimated	Harvested
1- Section 2	8 oz.	22	57	146
2- Roundup	16 oz.	22	50	142
No treatment		25	93	214
LSD @ 5% Level		3	NS	NS
CV(%)		6	57	28

Experimental Design-RCB w/3reps

Harvest date 7-1-2020

9/23/2019 application 7:15pm 65F ssw 4mph 60%RH
some standing water on east side of trial

		Rate/acre
1-Section 2EC	clethodim 2#/gal.	8oz.+1 Qt/acre-COC
2-Roundup PowerMaxII	glyphosate 4.5#/gal.	1 pt.+ 1pt.Amsol
Crop oil concentrate(COC)		
Amsol(AMS)=	3.3#dry AMS/gal	

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Table 18.

**2019-20 Fertility Management-MN-HD hard fescue
Magnusson Research Farm-Roseau,Mn**

Nitrogen ¹ #/acre	Nitrogen ¹ timing	RCI ² harvest	Harvest Ht(in.)	Seed Yield(#/acre) ³	
				Estimated	Harvested
0	0	190	20	90	47
80	7-May	647	25	87	121
120	23-Sep	452	24	123	160
120	7-May	452	24	83	104
80	23-Sep	701	23	100	116
LSD @ 5% Level		59	1	NS	99
CV(%)		6	3	24	48

Experimental Design-RCB w/3reps

Harvest date 7-1-2020

¹-Nitrogen-urea fertilizer in #/acre N and day of application

²-RCI- Relative chlorophyll index at harvest- higher number=more chlorophyll relative to other plots

³-Harvested yields were hand harvested 1m²/plot

Estimated yields- Visual estimate of yield to support actual harvested yield

Table 19.

**2019 Residue Management-MN-HD hard fescue
Magnusson Research Farm-Roseau,Mn**

Treatment ¹	Harvest	Seed Yield(#/acre) ²	
	Ht(in.)	Estimated	Harvested
Gramoxone/burn	24	183	180
Rake off	25	250	220
LSD @5% level	3	NS	NS
CV(%)	6	75	47

Experimental Design-RCB w/4reps

Harvest date 7-1-2020

¹-Gramoxone @ 1.5pt.+25%NIS 7-31-2019 11:00am 70F south wind 5-8mph

¹-Burned 8/9/2019 Spotty,poor burn quality rake off plots 8/6/2019

²-Harvested yields were hand harvested 1m2/plot

Estimated yields- Visual estimate of yield to support actual harvested yield

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Table 20a.

**2018 Hard Fescue Sulfur Fertility Trial-variety MN-HD1
Magnusson Research Farm-Roseau,Mn**

Fertility Treatment	Seed Yield(#/acre)	
	2019	2020
0	1046	263
25-0-0-30s ¹	881	463
LSD @5% level	NS	85
CV(%)	11	10

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Table 20b.

**2018 Kernza Sulfur Fertility Trial-variety- Clearwater
Magnusson Research Farm-Roseau,Mn**

Added Sulfur	Seed Yield(#/acre)	
	2019	2020
0	634	501
25-0-0-30s ¹	623	605
LSD @5% level	NS	NS
CV(%)	18	20

Kernza - 75% hulled and 5% ergot

Experimental design; RCB w/4 replications

Establishment and general management:

140-0-0 applied to all plots 5/8/2020

25-0-0-30s¹=125# ammonium sulfate/acre

MN-HD1 hard fescue @6#/acre was planted on 5/20/2018 with no cover

Kernza @10#/acre was planted under wheat on 5/20/2018

Table 21.

2020 Estimated Straw Value and Cost to Replace Removed Nutrients After Seed Harvest On 4 Grass Species

	\$\$ Value ³		Nutrient Removal/Replacement Cost ⁴				
	Yield Tons/ac. ¹	Total/acre Residue	\$\$/Ton Nitrogen	\$\$/Ton phosphorous	\$\$/Ton Potash	\$\$/ton N+P+K	\$\$/acre N+P+K
<u>Kernza Average-</u>	3.7	\$395.90	\$6.40	\$2.22	\$12.24	\$20.86	\$77.18
<u>Perennial ryegrass Average-</u>	1.7	\$193.05	\$8.74	\$2.94	\$15.84	\$27.52	\$45.40
<u>Ky.bluegrass Average-</u>	0.82	\$92.28	\$7.96	\$2.94	\$14.40	\$25.30	\$20.66
<u>Hard Fescue Average-</u>	1.0	\$129.92	\$11.79	\$3.30	\$16.08	\$31.17	\$29.56
<u>Spring Wheat Average-</u>	0.9	\$59.10	\$5.88	\$2.76	\$6.46	\$15.10	\$13.58

N (Urea) 46-0-0 =\$.39/#

P2O5(DAP) 18-46-0= \$.30(includes-\$.15/# due to N credit)

K2O(Potash) 0-0-60=\$.30/#

¹Yield tons/acre- dry matter per acre

³Value per acre is based on hay auction price with corn @\$4.50/bu.
soybean meal @ \$375/ton, and alfalfa @\$180/ton

⁴Cost of macro nutrient replacement from baled residue

⁵Forage quality of main dry matter components of residue

Table 22.

**2020 Estimated Straw Value and Cost to Replace Removed Nutrients
After Seed Harvest On 4 Grass Species**

Crop	Location	Prior year residue management	Planting Date	Variety	Yield Tons/ac. ¹	\$\$ Value/ Ton ²	\$\$ Value ³ Total/acre Residue	Nutrient Removal/Replacement Cost ⁴					Forage Quality of Removed Residue ⁵					
								\$\$ N/Ton	\$\$ P/Ton	\$\$ K/Ton	\$\$ N P K / ton	\$\$ N P K / acre	Moisture %	protein % crude	% ADF	% NDF	RFV	TDN
Kernza																		
F2B	MagPlots	Baled-2019	5/2018	LI-C5	3.9	\$107	\$417.30	\$6.40	\$2.22	\$12.24	\$20.86	\$81.35	7.8	4.2	41.7	61.2	85.8	56.5
F1	MagPlots	NA	8/2019	Clearwater	3.5	\$107	\$374.50	\$6.40	\$2.22	\$12.24	\$20.86	\$73.01	7.4	6.0	43.5	65.4	78.3	55.1
Kernza Average-					3.7		\$395.90					\$77.18	7.6	5.1	42.6	63.3	82.1	55.8
Ryegrass																		
Magnusson farms		NA	5/2019	Fiesta IV	1.5	\$117	\$175.50	\$8.74	\$2.94	\$15.84	\$27.52	\$41.28	7.3	7.4	44.5	64.2	78.7	54.3
Magnusson farms		NA	8/2019	Pillar II	1.0	\$117	\$117.00	\$8.74	\$2.94	\$15.84	\$27.52	\$27.52	7.3	6.6	44.0	65.4	77.8	54.7
Dahlgren farm		NA	5/2019	Vision	2.0	\$117	\$234.00	\$8.74	\$2.94	\$15.84	\$27.52	\$55.04	7.5	6.8	44.1	64.7	78.5	54.6
F5	MagPlots	NA	8/2019	Arctic Green	2.1	\$117	\$245.70	\$8.74	\$2.94	\$15.84	\$27.52	\$57.79	7.1	7.3	42.1	63.1	82.9	56.1
Perennial ryegrass Average-					1.65		\$193.05					\$45.40	7.3	7.0	43.7	64.4	79.5	54.9
Kentucky bluegrass																		
Eric Magnusson		Burn-2019	2017	Park	0.85	\$113	\$96.05	\$7.96	\$2.94	\$14.40	\$25.30	\$21.51	5.5	5.6	48.3	75.1	63.7	51.3
F5	MagPlots	NA	8/19	Park	0.85	\$113	\$96.05	\$7.96	\$2.94	\$14.40	\$25.30	\$21.51	7.2	5.1	40.0	57.1	94.4	57.8
Tony Brateng		Burn-2019	2018	Dragon	0.75	\$113	\$84.75	\$7.96	\$2.94	\$14.40	\$25.30	\$18.98	5.6	8.3	44.5	69.3	72.8	54.3
Kentucky bluegrass Average-					0.82		\$92.28					\$20.66	6.1	6.3	44.3	67.2	77.0	54.5
Fine Fescue																		
F2Aw	MagPlots	Burn-2019	2017	MN-HD	0.75	\$137	\$102.75	\$11.79	\$3.30	\$16.08	\$31.17	\$23.38	7.3	10.0	36.5	57.9	97.4	60.5
F2Aw	MagPlots	Baled-2019	2017	MN-HD	0.93	\$137	\$127.41	\$11.79	\$3.30	\$16.08	\$31.17	\$28.99	6.5	9.7	38.2	59.5	92.5	59.2
F5	MagPlots	Burn-2019	2017	MN-HD	1.70	\$137	\$232.90	\$11.79	\$3.30	\$16.08	\$31.17	\$52.99	7.6	9.6	33.5	52.9	110.7	62.9
F2A	MagPlots	Baled-2019	2018	MN-HD	0.75	\$137	\$102.75	\$11.79	\$3.30	\$16.08	\$31.17	\$23.38	7.3	9.6	37.2	59.0	94.6	60.0
F7SE	MagPlots	Baled-2019	2018	MN-HD	1.00	\$137	\$137.00	\$11.79	\$3.30	\$16.08	\$31.17	\$31.17	5.7	8.1	45.5	71.0	70.1	53.5
Magnusson farms		NA	2019	MN-HD	0.56	\$137	\$76.72	\$11.79	\$3.30	\$16.08	\$31.17	\$17.46	7.0	9.6	40.6	60.2	88.6	57.3
Hard Fescue Average-					0.90		\$129.92					\$29.56	6.9	9.4	38.6	60.1	92.3	58.9
Spring wheat																		
Magnusson farms		NA		Torgy	0.9	\$67	\$60.30	\$6.24	\$2.22	\$4.38	\$12.84	\$11.56	11.3	5.0	52.3	74.7	60.1	48.2
Magnusson farms		NA		Washburn	0.9	\$64	\$57.60	\$6.08	\$2.94	\$8.22	\$17.24	\$15.52	14.8	4.9	52.0	75.1	60.0	48.4
Magnusson farms		NA		Linkert	0.9	\$66	\$59.40	\$5.30	\$3.12	\$6.78	\$15.20	\$13.68	10.9	4.2	48.7	74.0	64.0	51.0
Spring wheat Average-					0.9		\$59.10	\$5.88	\$2.76	\$6.46	\$15.09	\$13.58	12.3	4.7	51.0	74.6	61.4	49.2

Experimental Design: 2 Random samples taken per treatment- no statistical analysis

N (Urea) 46-0-0=N =\$.39/#

P2O5(DAP) 18-46-0= P2O5(-\$.15/# due to N credit) =\$.30/#

K2O(Potash) 0-0-60= \$.30/#

¹Yield tons/acre- dry matter per acre

²\$\$Value/ton on dry matter basis

³Value per acre is based on hay auction price with corn @\$4.50/bu.,soybean meal @ \$375/ton, and alfalfa @\$180/ton

⁴Cost of macro nutrient replacement from baled residue

⁵Forage quality of main dry matter components of residue

Wheat straw residue-

Linkert-Malung

Torgy-Washburn- Roseau area

Yield= .9 tons/acre(Richard baled estimate) 12" approximate cut height

value= \$90/ton

Table 23.

2020 P & K Large Plot Fertility Soybean Trials
West Plant-Northern Resources and Jason / Greg Braaten Farms

Location 1-Braaten Farms P&K Tissue Samples Taken 7/30/20

Location 2-Northern Resources Tissue Tests take 7/20/20

Treatment	West			West		West		West		West		West		West		West		West		West		West			
	Braaten Plant Yield(Bu./Acre	Plant Mean @13%	Mean	Braaten Plant N %	Braaten Plant P %	Braaten Plant K %	Braaten Plant S %	Braaten Plant Ca %	Braaten Plant Mg %	Braaten Plant Zn ppm	Braaten Plant Fe ppm	Braaten Plant Mn ppm	Braaten Plant Cu ppm	Braaten Plant B ppm											
Normal(1)	30.6	43.5	37.0	5.8	5.1	0.39	0.38	1.4	2.3	0.30	0.30	1.47	1.13	0.64	0.48	25.8	20.8	93	71	70	68	9.2	7.3	54	41
Plus 50(2)	34.4	43.9	39.2	5.5	5.3	0.38	0.47	1.7	2.7	0.29	0.29	1.42	1.20	0.55	0.51	22.0	25.0	86	58	65	63	8.8	7.5	46	36
LSD @ 5% Level	4	NS	3.4	0.4	0.2	0.05	0.06	0.3	0.3	0.03	0.03	0.20	0.09	0.09	0.03	6.4	3.3	12	17	18	5	0.9	2.0	6	4
LSD @ 10% Level	3	NS	2.5	0.3	0.1	0.04	0.05	0.2	0.2	0.02	0.02	0.15	0.14	0.07	0.02	4.7	2.4	9	12	13	4	0.7	1.5	5	3
CV(%)	6	5	4	3	2	6	6	8	6	5	4	6	6	7	2	12	6	6	11	12	4	5	12	6	4

Braaten Farm Harvest and Soil Samples Taken 9/29/2020

Northern Resources Harvest and Soil Samples Taken 9/26/2020

Treatment	West		West		West		West		West		West		West		West		West		West		West		West			
	Braaten Plant N #/ac	Plant P ppm	Braaten Plant K ppm	Braaten Plant S #/ac	Braaten Plant B ppm	Braaten Plant Zn ppm	Braaten Plant Mn ppm	Braaten Plant Cu ppm	Braaten Plant Mg ppm	Braaten Plant Ca ppm	Braaten Plant OM %	Braaten Plant Salt dS/m	Braaten Plant CEC meq/kg													
Normal(1)	10.5	7.5	7.8	7.3	119	115	101	120	0.98	1.15	0.37	0.27	2.1	1.4	0.56	0.41	844	1103	5564	5113	5	4	0.58	1.30	35.4	35.8
Plus 50(2)	11.8	7.5	5.3	6.0	107	107	64	120	0.95	1.03	0.29	0.3	1.7	1.7	0.51	0.48	777	1116	5564	5265	5	4	0.44	1.50	34.8	36.7
LSD @ 5% Level	2.4	4.5	4.6	2.7	21	16	75	0	0.08	0.20	0.07	0.08	0.7	0.6	0.11	0.08	110	190	521	126	1	1	0.14	0.85	3.5	1.6
LSD @ 10% Level	1.8	3.3	3.4	2.0	16	12	56	0	0.05	0.15	0.05	0.06	0.5	0.4	0.08	0.06	82	140	386	93	0	0	0.10	0.62	2.6	1.2
CV(%)	9	27	31	18	8	6	41	0	4	8	10	12	16	17	9	9	6	8	4	1	5	6	12	27	4	2

Soil test date- Both locations- 5/4/2020

Treatment	West		West		West		West		West		West		West		West		West		West		West					
	Braaten Plant N #/ac	Plant P ppm	Braaten Plant K ppm	Braaten Plant S #/ac	Braaten Plant B ppm	Braaten Plant Zn ppm	Braaten Plant Mn ppm	Braaten Plant Cu ppm	Braaten Plant Mg ppm	Braaten Plant Ca ppm	Braaten Plant OM %	Braaten Plant Salt dS/m	Braaten Plant CEC meq/kg													
	11	9	10	6	155	148	84	120	1.2	1.2	0.48	0.34	2.8	1.8	0.66	0.46	937	927	5869	5722	5.7	3.9	0.58	0.47	37.7	36.9

Fertilizer sources-

Phosphorous(P)- 0-46-0

Potassium(K) -0-0-60

Fertilizer application dates-

Braaten-- 5/22/2020

Northern Resources--6/1/2020

Seeding Date-

Braaten-- 5/22/2020

Northern Resources--6/2/2020

Table 26.

**2020 Brassetto Rye Nitrogen Rate Trial
Amundson Farm-South of Roseau**

trt#	Fertilizer ¹ Application	Yield ² bu/acre	Harvest		Vigor ⁴	
			Ht.(in)	lodging ³	3-Jun	17-Jun
1	0	29.2	34	1.0	35	35
2	40-0-0	69.7	39	1.0	68	74
3	80-0-0	83.0	42	1.0	78	90
4	120-0-0	85.7	44	2.0	86	94
5	120-0-0-30s	86.2	44	3.3	90	97
6	160-0-0	94.1	44	1.5	78	93
7	200-0-0	90.8	44	2.0	89	94
LSD @5% level		9.8	2	1.0	10	7
CV(%)		8				

Experimental Design: RCB w/4 reps Harvest date=7/31/2020

¹-Fertilizer application 5/11/2020--GS 1-2" and 1-2 tillers

8-40-60 applied to all plots 9/19/2019

²-Yield @ 56#/bushel corrected to 12.5% moisture

³- Lodging1=upright;9=flat

⁴-Vigor- 100=dark green,vigorous growth ;1=dead

Growth stage on June 3 flag leaf emerged

XX

Table 26a.

**2020 Brassetto Rye Herbicide Screen
Amundson Farm-South of Roseau**

trt#	Treatment	Rate	Yield ¹ bu/acre	Ht.(in)	% Crop Injury ²			% stand 4-Aug	% Control	
					28-May	3-Jun	17-Jun		cockle	lambquarter
1	No Treatment	0	73.4	42	0	5	0	100	0	0
2	Bison	1pt	66.3	40	0	4	4	100	28	100
3	MCPA+Mox	.5pt+1pt	68.7	40	8	8	4	100	40	100
4	Curtail M*	2pt	61.4	41	20	13	5	100	33	100
5	Bison+Axial*	1pt.+1pt.	63.0	41	33	24	7	99	25	100
6	Huskie +2.5%AMS	14.9oz	67.2	40	0	11	0	99	70	100
LSD @5% level			NS(12)	NS	3	12	4	NS	25	0
CV(%)			12							

Experimental Design: RCB w/4 reps Harvest date=7/31/2020

* Treatments 4-5 had some stunting and trt #5 had some yellowing on June 3.

¹-Yield @ 56#/bushel corrected to 12.5% moisture

²-Injury rating- 0= no injury ; 100=dead

Fertility= 80-0-0 applied 5/8/2020 and 8-40-60 applied to all plots 9/19/2019

Trade name	Formulation
MCPA	3.7#/gal. MCPA- dimethylamine salt
Mox	2# bromoxynil
Bison	2# bromoxynil+2# mcpa- methyl-chlorophenoxyacetic acid
Huskie	.31# pyrasulfotole + 1.75# bromoxynil
Curtail M	2.35# clopyralid + 2# mcpa- methyl-chlorophenoxyacetic acid
Axial	.42# pinoxidin