

PROGRESS REPORT ON GRASS SEED PRODUCTION RESEARCH

prepared by

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Grass-Legume Seed Institute Presentation

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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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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.

Kentucky bluegrass

Establishment=Seed at 4#/acre in late August to early September.
120-40-40-10s applied in late September.
.75pt. 2,4-D a + .75pt. Sterling Blue late September.
Field burn in early August.

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 are 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 recording harvest data.
Experimental design usually consists of 2 or 3 treatment variables and 3 replicates/treatment.

2022 Research Locations

MagPlots=University of Minnesota-Magnusson Research Farm 2 miles north and 4.5 miles west of Roseau,Mn
MagFarms=Magnusson Farms- NW of Roseau
Brateng Farm= South of Roseau
Rice Farms= NW of Roseau
Estling Farm=North of Roosevelt
Stanley Farms=Grygla area

Table 1.

Monthly and Year End Precipitation Totals*
Roseau,Mn 1967-2022.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Yearly Total(in.)	Mean Deviation	Mean(F ^o)
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
2021	0.35	0.23	0.14	1.32	1.64	1.53	1.18	3.52	1.18	3.00	2.07	1.50	17.66	-5.02	42.1
2022	0.54	1.88	0.33	3.45	5.27	2.07	3.54	5.86	1.94	0.91	0.66	1.31	27.76	5.08	36.0
53 year average annual precipitation													22.68		
													51 year available mean temperature=	37.2	

*Precipitation amounts used are from the Magnusson Research Farm-near Roseau April/May-October and Minnesota Climatology Working Group nearest location or Fox NDAWN for the remainder of the year. Average precipitation the last 20 years=24.94". Average precipitation the previous 33 years=21.16"

Table 2.

2021 Perennial Ryegrass Seed Production Variety Trial
Magnusson Research Farm-Roseau,Mn. 2022 data and yields 2019-22

Company	Variety	Seed Lot#	Seed Yield(#/acre)					Seed Yield as % of Mean				Stand ¹	RCI ²		Harvest		Heading (%)			
			2022	2021	2020	2019	4yr.ave	2022	2021	2020	2019		5-5	6/4	6/17	Ht.(in.)	6/16	6/21	6/26	7/1
U of M	Spreader IIIxArctic Green	4051	1135	1199	1386	1233	1238	117	99	109	123	90	194	360	21	2	33	58	70	
U of M	Arctic Green	4156	1237	1324	1364	1347	1318	128	109	107	134	84	180	365	23	3	35	58	70	
U of M	EPR-18(early line)	4103	1123	1090	1264	----	1159	116	90	99	----	95	222	392	25	0	4	38	65	
check	NK-200	3917	941	1179	1130	810	1015	97	97	88	81	89	175	316	27	0	0	45	73	
U of M	Forage-select	4148R	975	1030	1017	731	938	101	85	80	73	93	222	386	23	2	5	53	73	
U of M	Galactic Green(3999)	4050	1179	1255	1286	1262	1246	122	103	101	126	91	176	385	23	3	10	58	70	
U of M	Green Emperor	3976	979	1173	1426	1060	1160	101	97	112	106	93	184	408	21	4	38	70	83	
U of M	Green EmperorxRoyal Green	4020	1039	1571	1384	1240	1309	107	129	108	124	91	188	417	21	8	50	73	89	
Mountain view seed	Superstar GL	4125	917	1242	1420	1145	1181	95	102	111	114	93	169	406	21	9	48	70	80	
Mountain view seed	Sliders LS	4126	777	1084	----	----	930	80	89	----	----	86	152	359	22	2	40	58	70	
DLF	Hancock	4155	879	----	----	----	NA	91	----	----	----	85	129	347	21	7	43	58	80	
Pure Seed Testing	Gray Fox	4129	883	1277	1259	977	1099	91	105	99	98	83	164	308	21	5	26	58	75	
Pure Seed Testing	Silver Sun	4128	821	1155	1130	907	1003	85	95	88	91	90	180	371	18	18	53	73	84	
Pure Seed Testing	Silver Sport	4130	683	1113	1310	1130	1059	70	92	103	113	78	142	357	20	6	43	68	73	
LSD @5% level			139	179	135	105	106	14	15	10	10	9	40	77	2	6	20	16	13	
CV(%)			10	10	7	7	7	10	10	7	7	7	15	14	7	82	40	19	11	
Trial mean by year			969	1215	1277	1003														

Experimental design:RCB with 4 reps

¹Stand-Visual rating of % plant stand

²RCI-relative chlorophyll index-Higher number=more chlorophyll

Planted 5/5/2021 with Linkert spring wheat @7#/acre

Harvest date=8/11/2022

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Table 3.

2021 Perennial Ryegrass Winter Hardiness Trial
Magnusson Research Farm Roseau,Mn & U of Minn. St. Paul Campus

Variety	Seed lot	Winter Injury ¹						Mean
		St.Paul	Roseau		Roseau			
		5/3/22	5/11/22	5/16/22	6/1/22	6/10/22		
Green EmperorxArctic Green	4031	1.0	8.0	9.3	8.3	8.3	8.4	
Green Emperor	3976	1.0	9.0	9.3	7.8	8.5	8.6	
Annual	4134	2.5	10.0	10.0	10.0	9.8	10.0	
Galactic Green-3999	4050	1.0	8.8	9.0	7.8	7.5	8.3	
NK-200	3917	1.3	8.3	8.5	7.3	6.8	7.7	
Hancock	4155	1.0	9.3	9.5	8.5	9.0	9.1	
Forageur	4043	1.0	7.3	7.8	5.0	5.3	6.3	
Arctic Green	4156	1.0	7.5	8.0	5.8	5.5	6.7	
Spreader IIIxArctic Green	4051	1.0	8.3	9.3	7.5	8.0	8.3	
Forage sel-2019	4150	1.0	8.3	8.0	5.5	5.0	6.7	
Silver Sport	4130	1.0	8.3	8.8	7.3	6.8	7.8	
Forage sel-2020S	4149S	1.0	8.5	9.0	7.8	7.8	8.3	
Forage sel-2020R	4148R	1.0	8.5	9.3	7.8	8.5	8.5	
Forage sel-2019	4116	1.0	9.0	9.3	8.0	7.5	8.4	
LSD @5% level		0.3	1.5	1.0	2.1	2.0	1.3	
CV(%)		18	12	8	20	17	12	

Experimental design:RCB with 4 reps

Planting date- Roseau=9/9/2021 ; St.Paul 9/22/2021

¹Winter injury(visual rating) 1= no injury; 10=dead.

Table 4.

**2020 Kentucky Bluegrass Variety Trial
Magnusson Research Farm-Roseau,Mn**

LINE	source	MSP#	Seed Yield		Harvest		Heading (%)				
			#/ac	% of mean	Ht.(in.)	Date	5/31	6/4	6/8	6/13	6/17
318west	UM	4120	429	68	24	21-Jul	0	T	2	23	40
610middle*	UM	4121*	354	56	24	21-Jul	0	3	9	18	33
704east*	UM	4122*	427	68	24	21-Jul	0	4	11	23	35
A99-3124	MN-Rutgers	3920	445	70	24	21-Jul	0	T	7	20	35
Minnfine	check	4063	736	116	31	7-Jul	5	45	75	100	100
Park	check	4062	857	136	29	7-Jul	3	18	58	93	100
Dragon	check	4131	825	131	27	12-Jul	0	T	13	65	91
Exp#1	exp	4132	952	151	26	12-Jul	0	8	13	48	78
Desert Moon	PST	4135	705	112	24	14-Jul	0	0	3	35	65
New Moon	PST	4136	594	94	26	14-Jul	0	5	16	50	80
LSD @5% level			100	15	3	2	1	11	12	12	10
CV(%)			11	11	10	3	102	90	40	17	10

Experimental design:RCB with 4 reps

Seeded 8/5/2020 @5#/acre

*Significant off type contamination of these lines

Mean trial yield= 632#/acre

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Table 5.

**2019 Fine Fescue Seed Production Variety Trial
Magnusson Research Farm-Roseau,Mn. 2022 data +2021-2 Seed Yield.**

Variety	Fescue species	Seed Lot#	Seed Yield(#/acre)				Harvest Ht.(in.)	Heading (%)			
			2022	2021	2020	3yr.ave		5/31	6/4	6/8	6/14
MN-HD	Hard	4065	269	1128	906	767	20	5	43	63	88
SPHD	Hard	2	167	1006	765	646	18	5	45	68	88
Beacon	Hard	3	80	690	699	489	21	T	25	55	90
Gladiator	Hard	4	109	467	579	385	21	3	30	55	90
Jetty	Hard	5	131	959	681	590	21	2	23	55	90
Radar	Chewings	6	776	788	661	742	29	T	16	45	80
Chantilly	St.creeping	7	116	58	402	192	23	0	T	8	40
LSD @ 5% level			84	209	103	87	1	3	12	14	6
CV(%)			24	19	10	11	4	95	33	18	5
Trial mean by year			235	728	670						

Experimental design:RCB with 4 reps

Planted 5/10/2019 with no companion crop @6#/acre

All plots harvested 7/11/2022

Table 6.

2017 Intermediate Wheatgrass-Kernza Variety Trial**Magnusson Research Farm-Roseau,Mn. 2022 data and 2018-2022 Seed Yield**

trt#	Variety	Seed Yield-#/ac					Mean	Harvest		% heading			
		2018	2019	2020	2021	2022		lodging ²	Ht.(in.)	6/22	6/26	7/1	7/6
4	MN-Clearwater	734	917	792	888	1046	875	1.0	59	23	50	80	97
5	MN1505-Syn 2	670	910	832	901	930	849	1.5	60	25	60	80	96
2	MN1502-Syn 2	512	848	881	863	883	797	1.3	62	18	60	85	97
3	MN1503-Syn 2	558	770	857	906	954	809	1.8	60	13	48	78	96
11	2015 C4	725	761	541	948	890	773	2.0	61	18	63	85	98
8	2016 C5	496	757	685	823	828	718	2.0	60	16	48	88	98
7	2016 C4	558	774	498	874	914	724	2.8	59	23	55	88	98
9	2016 3471 Selfs	514	721	472	781	757	649	3.5	60	11	50	83	96
6	2016 C3	501	705	363	719	828	623	3.0	60	20	50	85	97
10	Lot # SFD - 12 - Thin 6 - 4-10	625	670	242	683	438	531	5.5	57	7	38	73	93
1	MN1501-Syn 2	554	554	267	710	683	554	3.0	60	11	45	73	94
12	Rush	483	374	138	476	305	355	6.3	55	9	35	65	90
	LSD @ 5% Level	154	86	78	165	133	67	1.1	4	9	12	9	4
	CV(%)	18	8	10	14	11	6	28	5	40	17	8	3
	Mean yield by year	484	730	547	798	788							
	Mean Top 4 yield	519	861	841	911	961							

Experimental design:RCB with 4 reps

Seeded 8/15/2017 @ 10#/acre

Harvest Dates=8/23/22, 8/10/2021, 8/20/2020, 8/21/2019 & 8/23/2018

Crop Management-

Fertilizer application= 140-40-40-10s applied annually in October starting in 2018.

Residue management= Chop/bale off 9/2018. Burn after harvest 9/2019, 20, 21, & 22.

XXXX XXX

table 7.

2020 Intermediate Wheatgrass-Kernza Variety Trial**Magnusson Research Farm-Roseau,Mn. 2022 data and 2021-2022 Seed Yield**

Seed lot#	Variety	Seed Yield-#/acre			Ht.(in.)		% heading			
		2021	2022	Mean	Harvest	Hulled % ¹	6/22	6/26	7/1	7/6
4138	TLI 701	997	1335	1166	60	84	14	55	78	97
4139	TLI 702	955	1141	1048	58	89	23	68	90	99
4140	TLI 703	1068	1144	1106	61	75	23	60	85	98
4141	TLI 704	1108	1037	1072	61	89	11	63	85	97
4146	TLI -C5	1001	1079	1040	64	65	14	58	88	98
4142	MN-1601	948	943	946	63	70	7	43	83	98
4143	MN-1603	1012	930	971	58	68	4	30	68	88
4144	MN-1605	872	981	927	62	61	8	60	80	97
4145	MN-1607	1084	939	1011	64	61	4	35	70	93
4147	MN-Clearwater	1001	1099	1050	62	75	11	53	85	98
	LSD @ 5% Level	145	140	97	4	8	7	13	7	3
	CV(%)	10	9	6	5	7	41	24	6	2

Experimental design:RCB with 4 reps

All harvested 8-23-2022

Planted 8-20-2020 @ 10#/acre

¹Hulled %= visual estimate of % hulled seed after threshing and cleaning²Lodging-1=upright;9=flat

Fertilizer application= 140-40-40-10s 10/2021

Residue burned 8/25/2021

Table 8.

2022 Field Pea Variety Trial**Magnusson Research Farm. 2022 data and 2019-2022 grain yield**

Variety	Yield Bu/acre ¹				Protein %	Harvest		50% Flower	Bushel Wt.
	2022	2021*	2020*	2019		ht(in)	Lodging ²		
1 AAC Chrome	119.3	58.5	NA	NA	22.1	38.0	3.0	14-Jul	64.9
2 AAC Profit	108.0	48.5	36.2	108	24.4	40.0	1.7	15-Jul	65.0
3 Spider	104.7	46.2	24.5	96	22.7	41.0	5.0	13-Jul	64.4
4 Salamanica	75.0	49.8	36.6	96	22.9	38.0	1.0	12-Jul	62.5
LSD @ 5% Level	9.0	14.1	14	11	0.7	NS	2.0	1.0	0.9
CV(%)	5	16	34	7	2	5	37	4	1

Experimental Design: RCB w/3 reps

*Flooding in 2020 and drought in 2021 may have reduced yields.

¹Yield=Bushels per acre at 12% moisture.

²Lodging 9=Flat;1=upright

Management-

Herbicide application-

Authority Elite 1.5pt.acre applied immediately after planting .

Site= Conventional tillage seedbed- Non-irrigated

Fertility application 8-40-40 Soil type- sandy loam

Previous crop- spring wheat

Planting Date= 5/28/2022

Harvest date- Field Peas- 9/2/2022

Field pea Seeding Rate= 350,000PLS/acre

Table 9.

2021-22 Perennial Ryegrass Fertility Trial Magnusson Research Farm-Roseau,Mn

TRT# *	Total	Seed Yield	Stand ¹	6/17/2022		Harvest		
	N level	#/acre		RCI ²	Color ³	Date	Lodging ⁴	Ht(in.)
1	0-0-0	380	3.3	147	2.7	8-Aug	1.3	17
2	140+0+0	1172	5.3	208	4.0	11-Aug	1.7	19
3	140+40+0	1613	5.7	243	5.3	9-Aug	2.0	20
7	140+0+0+20s	1789	7.0	499	9.0	6-Aug	2.0	20
	LSD @5% level	236	2.3	71	0.9	NS	NS	2
	CV(%)	9	21	13	9	36	31	4

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

Perennial ryegrass spring seeded 5/2021 under wheat.

* Only 3 replications harvested on selected plots.

Stands of other treatments were too variable to harvest.

Trt#	Total #N Season	Treatment applications and timing	Treatment Explanation
1	8	8-40-40	No added N
2	140	30-0-0 on 10/19 + 95 -0-0 on 5/10	30#N oct- STANDARD- BMP
3	140	30-0-0 on 10/19 + 95-40-0 on 5/10	Standard + 0-40-0 spring
7	140	30-0-0-20s on 10/19 + 95 -0-0 on 5/10	30#N oct + 20# sulfur Oct(82#AMS)

All plots received 8-40-40 9/1/2021

fall treatments-10-19-2021

TRT#2 - Standard application= 30#N on 10/19/2021
and remaining 110#N on 5/10/2022.

10/19/21 Soil test results

Depth	Olsen P	K	% OM	PH	NO3-N
0-6"	16 ppm	98 ppm	2.9	8.2	8 ppm
6-24"					16 ppm

¹Visual Stand Rating- 1=poor stand;9=full stand

²RCI-Relative Chlorophyll Index-higher number= more chlorophyll

³Color-1=light green;9=dark green

⁴Lodging-1=upright; 9=flat

Table 10.

2011-22 Perennial Ryegrass Fertility Trial Seed Yield Summaries Magnusson Research Farm-Roseau,Mn

Trt. #	Nitrogen Fertilizer	Nitrogen Timing	Overall ³ Mean	Seed Yield as % of Mean											
				2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011
1	0	0	29	25	26	24	20	21	45	38	29	27	28	21	36
2	100+0+0	Split ¹	98	----	91	99	103	90	104	90	----	92	96	112	108
3	140+0+0	Split ¹	107	77	104	104	111	101	99	110	99	104	104	118	118
4	140+40+0	Split ¹ +(0-40-0spring)	108	106	99	96	100	107	106	109	127	120	----	----	----
5	140+0+0+20s	Split ²	101	117	104	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	Spring only	103	----	106	104	99	94	91	106	----	96	104	119	115
LSD @5% level				15	12	10	13	11	13	12	20	11	16	11	12
CV(%)				9	9	8	10	8	9	9	16	8			

Experimental Design:RCB with 4 reps

Variety all years=Arctic Green

Yield Trial mean by year (#/acre)-- 1525 1276 1584 1668 1631 1627 1220 1344 1244 1068 1499 1313

¹Split-30-40-40 applied fall and remainder in spring(increased to 30-50-50 in 2019)²Split-30-50-50-20s(77#AMS / acre) applied in fall+110-0-0 in early May³Treatment overall means should be viewed with caution when there are limited number of years-(ie-#6-7)

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

Table 11.

2022 Fertilizer Added Late to Per. Ryegrass That Has Been Flooded
Rice Farm-Roseau,Mn Variety=Patriot 4

Trt#	Added ¹ Fertilizer	Fertilizer Source	Yield ²		RCI ³ 8/10	Harvest Ht.(in.)
			#/acre	Estimated		
1	40-0-0	Urea-46-0-0	609	800	486	22
2	0-40-40	0-46-0 + 0-0-60	667	775	396	20
3	40-0-0 ¹	13GPA-28%N	634	800	399	21
4	None	0	634	800	383	20
LSD @5% level			NS	NS	89	NS
CV(%)			10	10	13	9

Experimental Design: RCB w/4 reps

Variety= Patriot II

¹Treatr Liquid 28% N sprayed on with flat fan nozzels @ 13GPA

²Yield= Actual harvested yield and visual estimate prior to harvest

³Relative Chlorophyll Index- higher number=more chlorophyll

Harvest date=8/11/2022

All Fertilizer applied- 6/10/2022

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Table 12.

2022 Growth Regulator Applications to Per. Ryegrass
Rice Farms-Northwest of Roseau,Mn

Trt#	PGR treat	additive	Seed Yield #/acre	Harvest Ht(in.)	Lodging ⁴		
					14-Jul	21-Jul	Harvest
1	No treatment		883	29	6.3	7.3	7.8
2	Apogee 6oz.	.25%NIS+4.5gal.UAN	1081	25	1.8	3.3	3.8
3*	Apogee 6oz.	.25%NIS+6gal.AmSol	943	26	2.3	4.3	4.5
4	Apogee 6oz.	.25%NIS+6gal.UAN	932	24	1.5	4.0	4.0
5	Apogee 6oz.	.25%NIS+3gal.UAN	1021	25	1.3	3.8	3.8
6	Apogee 8oz.	.25%NIS+3gal UAN	979	23	1.5	3.0	3.0
7	Apogee 8oz.	.25%NIS+2.5% UAN	1057	24	2.0	2.8	3.0
8	Apogee 8oz.	.25%NIS+3gal.AMS	932	24	3.0	3.5	3.3
LSD @5% level			124	2	1.3	1.3	1.6
CV(%)			8	5	38	24	26

Experimental design=RCB w/4reps

Variety= Patriot II

Harvest date=8/4/2022

1.7Pt Wolverine+8oz.AmSol+ 2oz. Warrior applied 6-23-2022 to all plots

*Trt#3 had some product precipitated out with the high AmSol

1 gallon AmSol = 3.4# AMS(6gallons= 20#AMS/acre)

1gal=3.4#ams(21-0-0-24s) .7#N-0-0-.8#s

1gal 28%UAN=3#N

Applications made6-22-2022. Canopy= 23-26" and 3-4 nodes

78F 37%RH SW4-10mph 6-22-2022 7PM

Applications may have been later than ideal.

Table 13.

2022 Pre-emergent Herbicides applied to Ryegrass**Rice Farm- Roseau,Mn**

48 52.627'N . 95 52.000'W

TRT#	Trade Name	common name	Product Rate/acre	Seed Yield ¹		Stand ²		Injury ³	Harvest	
				#/acre	Estimated	2-Jun	14-Jul	11-Jun	Date	Ht(in.)
1	Zidua SC	pyrooxasulfon	2oz.	1066	1000	63	68	6.0	10-Aug	23
2	Callisto	Mesotrione	6oz.	1095	1350	100	93	1.8	5-Aug	23
3	Boundary	metribuzin+metalachlor	1.5pt	832	925	73	58	5.5	10-Aug	23
4	Aatrex	atrazine 4L	1pt	779	950	75	73	3.8	8-Aug	22
5	Aatrex	atrazine 4L	2pt	458	650	63	35	6.8	11-Aug	20
6	GoalTender+Nortron	oxyfluorfen+ethofumisate	2oz+2pt	1072	1400	100	100	2.0	5-Aug	23
7	Dual II Magnum	metalachlor	1pt	1059	1275	85	85	2.8	7-Aug	24
8	Avadex	trallate	15#	1003	1050	63	68	4.5	10-Aug	23
9	Anthem Flex	Carfentrazone-ethyl + pyrooxasulfone	3oz	814	875	40	50	6.8	11-Aug	23
10	Anthem Flex	Carfentrazone-ethyl + pyrooxasulfone	4oz	602	825	40	50	7.5	11-Aug	20
11	No treat			1099	1300	100	98	1.0	5-Aug	23
12	No treat-Harrow			1161	1325	100	100	1.0	6-Aug	24
13	Avadex-Harrow	trallate	15#	1061	1025	73	88	4.8	8-Aug	23
LSD @5% level				168	191	20	17	1.1	2	2
CV(%)				12	12	18	16	19	16	6

Experimental Design: RCB w/4 reps

Variety=Patriot 4

All treatments(except Avadex) applied 11am 5/6/2022. wind SE 9-14 64F 52%RH

GS-ryegrass just beginning to greenup--wheat stubble 7" high.

Application made w/ 10' bike sprayer 8002 T-Jet nozzels @26PSI and 12GPA

Avadex applied 7pm 5/6

Rainfall after application 5/8=0.43", 5/9=1.24", 5/11 =0.5"

Trts. 12-13 spike tooth harrowed 5/7 8am

Soil type=Borup silt loam

Anthem Flex Carfentrazone-ethyl .3# + Pyrooxasulfone 3.7#

Aatrex 4# atrazine

Avadex 10%trallate

Goal Tender 4# oxyfluorfen

Dual II Magnum 7.6# metalachlor

Zidua SC pyrooxasulfon 4.17#/gal

Nortron 4# ethofumisate

Callisto 4# Mesotrione

Boundary 5.25#metalachlor+ 1.25# metrabuzin

¹Seed Yield- actual harvested clean seed and visual estimate²Stand- visual %stand³injury/suppression-visual rating- 1=no injury 9=severe injury

Table 14.

**2022 Perennial Ryegrass Management Additive Trial
Magnusson Research Farm**

Trt#	Herbicide Treatment ¹	Rate	Manage Level ²	Seed Yield(#/acre)				% stand	Ht(in.)
				2022	2021	2020	3yr.ave		
1	Callisto+Sterling Blue+2,4-D/Assurell	3oz+12oz+12oz/12oz	BMP	1324	1297	1370	1330	86	21
2	Callisto+Sterling Blue+2,4-D/Assurell	3oz+12oz+12oz/12oz	BMP	1340	1388	1546	1425	86	22
3	Callisto+Sterling Blue+2,4-D/Assurell	6oz+12oz+12oz/12oz	BMP	1430	1206	NA ³	1318	86	23
4	Sterling Blue+2,4-D/Assurell	12oz+12oz/12oz	BMP -	1408	1235	1506	1383	85	23
5	Sterling Blue+2,4-D/Assurell	12oz+12oz/12oz	BMP	1428	1374	1412	1405	90	22
6	Sterling Blue+2,4-D/Assurell	12oz+12oz/12oz	BMP +	1422	1224	1541	1397	90	23
7	Sterling Blue+2,4-D/Assurell	12oz+12oz/12oz	BMP ++	NH*	1197	1356	----	----	----
8	Wolverine Advance	1.7pt +1pt.	BMP	1442	1304	1359	1368	86	21
9	Facet+2,4-D+Sterling Blue	1.5pt+12oz+12oz	BMP	NH*	1257	1362	----	----	----
10	Sterling Blue+2,4-D+Dual II/Tacoma	12oz+12oz+1pt/12oz	BMP	NH*	1311	1394	----	----	----
11	No Treatment		BMP	1430	1108	1263	1267	86	23
LSD @ 5% Level				168	148	138	146	NS	NS
CV(%)				8	8	5	5	6	7
Experimental design:RCB with 4 reps			Mean Yield-	1403	1264	1411			

¹Herbicide treatment- stand issues in certain areas of the field precluded getting at least 3 replications of some treatments. These treatments had stand not sufficient for comparison (trts.7,9 & 10).
Harvest date=8/6/2022

Variety=Arctic Green-- 3/4pt 2.4-D+3/4pt.Banvel applied 9-20-2021 to all plots

²Management level- higher or lower than best management practice on treatments other than herbicide

³6 oz. Callisto treatment 2021-22 only

6/4 broadleaf herbicide 9am 57F wind N3 GS 2-5" tillering
6/10 grass herbicide= 10am 64F
6-17 Apogee 11:30am 69F wind 3NE GS tillering-10%headed
6-27 Fungicide = 9:30am wsw 2-6mph 70F
early pollen shedding

BMP = (Best management practice) 6oz. Apogee+2 Gal. 28%N +low cost fungicide / premium fungicide + 1gal 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# 2021 Treatment and Date

1--	3oz.Callisto+2,4-D+Banvel 6-4 /Assurell 6-10/ Apogee + Tilt+ 2 gal 28%N 6-17 / Priaxor +1 gal 28%N 6-27
2--	3oz Callisto+ 2,4-D+ Banvel 6-4 +MSO+28%N 6-4/ Assurell 6-10/ Apogee + Tilt+ 2 gal 28%N 6-17 / Priaxor +1 gal 28%N 6-27
3--	6 oz Callisto+ 2,4-D+ Banvel 6-4/ Tacoma 6-2/ Apogee + Tilt+ 2 gal 28%N 6-17 / Priaxor +1 gal 28%N 6-27
4--	2,4-D+ Banvel 6-4/ Assurell 6-10/ Apogee + 2gal 28%N 6-17 / Folicur 6-27
5--	2,4-D+ Banvel 6-4/ Assurell 6-10/ Apogee + Tilt+ 2gal 28%N 6-17 / Priaxor 6-25+1gal 28%N 6-27(standard BMP)
6--	2,4-D+ Banvel 6-4/ Assurell + 2gal 28%N +Folicur 6-10/ Apogee + Quilt+ Warrior+2gal 28%N 6-17 / Priaxor +1gal 28%N 6-27
7--	2,4-D+ Banvel 6-4/ Tacoma + 2gal 28%N +Folicur 6-10/ Apogee + Quilt+ Warrior +2gal 28%N 6-17 / Priaxor +Warrior+1gal 28%N 6-27
8--	2,4-D+ Banvel 6-4/ Tacoma +2 gal 28%N +Folicur 6-10/ Apogee + Quilt +2gal 28%N 6-17 / Priaxor-1gal 28%N 6-27
9--	Wolverine 6-10/ Apogee + Tilt + 2gal 28%N 6-17 / Priaxor + 1gal 28%N 6-27
10--	2,4-D+ Banvel+Dual II Magnum 6-4/ Tacoma 6-10/ Apogee + Tilt+ 2 gal 28%N 6-17 / Priaxor +1 gal 28%N 6-27
11--	NO HERBICIDE--Apogee + Tilt+ 2 gal 28%N 6-17 / Priaxor +1 gal 28%N 6-27

Trade Name	Common name -Active ingredient/gallon(or % dry)	Use Rate/acre
Quelex	10% halauxifen+10% florasulum	.75oz
WideMatch	.75#CLOPYRALID + .75#FLUROXYPYR	1pt
Assure II	.88# Quizalofop	12oz
Callisto	4# mesotrione	3oz
Sterling Blue	4# Dicamba	.75pt
2,4-D	4# 2,4-D amine	.75pt
Wolverine Advance	.4#Fenoxaprop +13#pyrasulfotole+1.05#bromoxynil	1.7pt
Apogee	27.5% PROHEXADIONE CALCIUM	8oz
Preference	Non-ionic surfactant(90%NIS) (.25%NIS)	1qt./100gallons water
Amsol	1gallon=3.4# dry AMS =.7#N/gal	1 pt
28%N	2.9#N(UAN)/Gal	3 gal
MSO-Destiny	92%MSO	1 gallon/100gallons
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#LAMBDCYHALOTHRIN	1.5oz
Folicur	3.6#Tebuconazole	4oz

Table 15.

**2022 Ryegrass Fungicide Trial-
Rice Farms-Northwest of Roseau,Mn**

Trt#	Product	Rate/acre	Seed Yield Harvest	
			#/acre	Ht(in.)
1	Quilt Xcel	12oz+.25%NIS	1010	24
2	Folicur	5oz+.25%NIS	941	24
3	Priaxor	6oz+.25%NIS	952	23
4	Quilt Xcel	12oz+.25%NIS+3gal.Amsol	990	24
5	Quilt Xcel	12oz+.25%NIS+3gal. 28%N	990	23
6	Revytek	8oz+.25%NIS	1032	23
7	No treatment		952	23
LSD @5% level			NS	NS
CV(%)			10	6

Experimental design=RCB w/4reps

Variety=Patriot 4

Harvest date=8-2-2022

Nexicor fluxapyroxad .25#,pyroclostrobin 1.67#,propiconazole 1.04#

Priaxor fluxapyroxad 1.39#,pyroclostrobin 2.78#

Folicur 3.6F tebuconazole 3.6#

Quilt Xcel Azoxystrobin 1.18#, propiconazole 1.02#

Grizzly Z II Lambda-cyhalothrin 2.08#

Warrior w Lambda-cyhalothrin 2.08#

Revytek (menfentrifluconazole + pyraclostrobin + xemium) = BAS 753

Lamcap II Lambda-cyhalothrin 2.08#

Applications made 7/6/2022. 5:30PM. 78F 57%RH,wind S 11mph Pcldy.
GS=22-25" ht.

Table 16.

**2021-22 Callisto-Nortron on P Ryegrass
Magnusson Research Farm-Roseau,Mn**

Trt#	Early fall	Fall/spring	Date	Yield #/acre	Harvest Ht.(in.)
1	Callisto	Callisto	6-May	1357	19
2	Nortron	Callisto	6-May	1317	21
3	0	Callisto	6-May	1268	24
4	Callisto	Callisto	25-Oct	1206	20
5	Nortron	Callisto	25-Oct	1393	23
6	0	Callisto	25-Oct	1473	20
7	Callisto	No treatment	0	1402	22
8	Nortron	No treatment	0	1410	23
9	0	No treatment	0	1264	22
10	Callisto	Nortron	6-May	1615	20
11	Nortron	Nortron	6-May	1549	20
12	0	Nortron	6-May	1486	20
13	Callisto	Nortron	25-Oct	1161	20
14	Nortron	Nortron	25-Oct	1375	20
15	0	Nortron	25-Oct	1357	18
LSD @ 5% Level				NS	3
CV(%)				16	6

Experimental Design:RCB w/4reps(only 2 reps harvested)

Harvest date 8/10/2022

Early Fall (9-9-2021) Rates & adjuvants applied 9/9/2021 12:30pm 66F wind 2-5 ssw

Callisto 3oz+1%CO₂+2.5%UAN ryegrass 2-3" overcast

Nortron 2pts wheat 2-3" 1-2leaf RH62%

Fall/Spring(10/25&5/6)Rates

Callisto 6oz. Applied 5/6/22 6pm mostly sunny

Nortron 2pts wind ssw10 65F
Ryegrass just greening up

Trade

Name	Common name
Callisto	Mesotrione 4#/gal.
Nortron SC	Ethofumisate 4#/gal

Table 17.

**2022 Triallate Formulation Applications to Linkert Spring Wheat
Magnusson Research Farm-Roseau,Mn**

Trt No.	Treatment Name	#/acre	Rate lb ai/a	Yield ¹ Bu./acre	Test Wt./Bu	Plant Ht(in.) at harvest	Visual ² suppression 6/11/22
1	Untreated Check		0	71.1	60.7	30	1.0
2	Avadex	12.5	1.3	60.2	60.7	28	5.0
3	Avadex	15.0	1.5	57.5	60.7	29	4.3
4	GWN 0014163	8.3	1.3	60.0	60.7	29	3.3
5	GWN 0014163	10.0	1.5	59.6	60.6	29	4.5
LSD @5% level				5.0	NS	1	1.7
CV(%)				5.3	0.4	2.7	30.1

Experimental Design; RCB w/4 reps Plot size=8' x 30'

¹Yield= corrected to 12% moisture

²Visual suppression=1=no stand loss or vigor reduction;
9=heavy stand loss and plant suppression.

Treatment Name Form Conc

Avadex 10G

GWN 0014163 15G

Applications= 5/26/22 2pm 62f

wind ne5 54%RH sunny 20% cloud cover

1 shallow pass(2") prior with field cultivator and harrow after application before planting

Planting Date= 5/27/2022 Harvested 9/2/2022

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Table 18.

**2020 & 2021 Wheat Combine Stubble Height with Underseeded Ryegrass
Harvested Perennial ryegrass seed in 2021 & 2022
Magnusson Farms-1 mile west of Roseau on Adjacent Fields both years**

2022 Harvest					2021 Harvest	
Stubble Height	Seed Yield ¹ #/acre	Vigor ³ 23-May	%stand 23-May	Reps ²	Stubble Height	Seed Yield ¹ #/acre
2-3"	1200	2	55	2	2"	1845
5-6"	1312	4	80	4	5"	1717
7-9"	1444	4	80	2	NA	NA
10-14"	1176	5	90	2	10"	1575

Plot size=45' x 1020' Wheat Harvest date-8/1/2021- (Straw baled after harvest)

¹- Clean seed yields from weigh wagon.

Subsamples cleaned and yields corrected to 12.5%moisture.

²-Strips of each stubble height treatment

³-Vigor- 1=poor; 9=good

Table 19.

**2021-22 Wheat Stubble Management for Production of P Ryegrass
Magnusson Research Farm-Roseau.Mn**

Trt#	Product	Rate/acre	Seed Yield		%Stand		Vigor ¹	Harvest Ht(in.)
			#/acre	Estimated	6-May	14-Jun		
1	no treatment		1386	1275	80	80	7.8	21
2	spring Clip 3"		1415	1325	75	78	7.0	21
3	spring Clip 3"- bale off		1353	1375	70	73	7.3	21
4	Fall clip 3"- bale off		1377	1025	30	40	3.8	22
5	Fall clip 5"-10-11-21		1435	1250	65	73	7.0	21
	LSD @5% level	NS	172	17	14	1.5	2	
	CV(%)	12	9	17	14	15	6	

Experimental Design:RCB w/4reps

¹Vigor-1=poor;9=good

Spring clip 5/6/2022

Fall clip 10/11/2021

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Table 19a.

**Spring Residue Management Seed Yield Summaries-2018-2022
Rice Farms 2018 and 2021
Magnusson Research Farm-2019-22**

Trt#	Clip Treatment ¹	Seed Yield-#/acre					Mean
		2022	2021	2020	2019	2018- ²	
1	No Treatment	1386	1172	1395	1386	1430	1353
2	Clip only	1415	1222	1475	1497	NA	1402
3	Clip-Rake off	1353	1380	1537	1611	1610	1498
	LSD @ 5% Level	NS	118	NS	197	63	
	CV(%)	12	5	8	7	2	

Experimental Design:RCB w/4reps

Fall wheat stubble combine height=6"-8"

Varieties= Rice farm- 'Evolution'

Magnusson Research farm-'Arctic Green'

¹-Clip only or clip and remove straw late April-early May

Clip height=3"

²-No clip treatment in 2018 from Rice Farms location.

Plot size about 10' x 30'. Stubble cut with sickle mower or lawn mower

Residue on Trt#3 raked off by hand.

Table 20.

%Endophyte on Seed Produced in 2022^a

Cultivars	Production	
	Area	Endophyte
Furlong	Badger	80%
Galactic Green	Wannaska	0%
Defender	Roseau	0%
Interlude	Roseau	30%
Coda	Roseau	5%
Peridot	Roseau	20%
Reservoir	Roseau	0%
Hancock	Roosevelt	20%
Fiesta IV	Roseau	50%
Galactic Green	Roseau	0%
Karma	Roseau	5%
SR4700	Roosevelt	65%
Allaire III	Pine creek	50%
Patriot IV	Roseau	5%
Fiesta Cinco + Sideways	Grygla	80%
Silver Dollar	Grygla	5%
Spark	Grygla	60%
Sideways	Roseau	15%
Gator III	Roseau	0%

Epichloë endophytes are fungi growing inside grass leaf sheaths and leaves.

This fungus can protect the plant from insect damage by producing certain alkaloid compounds.

These alkaloids include lolines, lolitrems, ergovaline and peramine.

Strains of Epichloë endophytes can produce none of those up to all of them.

The presence of endophyte in grass tissue does not indicate with certainty that all these alkaloids will be produced;

Furthermore, accumulation of these alkaloids can be different between the plant's organs (roots, stem, leaf sheath, leaves, panicles and seeds).

Two of these alkaloids have negative impact on animal health.

Ergovaline is associated with "fescue toxicosis" (from tall fescue) and can affect many grazing animals such as cattle, sheep, goats, horses, and even deer.

Lolitrems B provokes "ryegrass staggers" (from perennial ryegrass) by impacting cattle, sheep and horse muscular coordination.

We tested the presence of endophyte in freshly harvested (summer 2022), threshed and clean seeds from various growers in different Northern Minnesota areas.

We observed that 5 of the 19 seed-lot tested were free of endophyte; the remaining seed-lots contained endophyte with percentage ranging from 5% to 80%.

The test allowed us to determine the endophyte presence and incidence but we do not know the alkaloid profiles present the colonized perennial ryegrass cultivars.

Galactic green cultivar did not possess any endophyte in two different seed-lots tested.

The residue from this perennial ryegrass cultivar could be ideal in cattle feeding after seed harvest.

However, the absence of the endophyte indicates that no protection from insect damage will occur and growing fields will have to be monitored closely for any above ground feeding insect infestation.

^a Text and summary table courtesy of Dr. Florence Sessoms-University of Minnesota.

Table 21 .

**2020-21 Kernza Residue Management
Magnusson Research Farm. 2022 Data and 2021-22 Yields.**

TRT#	Treatment	Seed yield #/acre			Harvest Ht(in.)	% Heading			
		2021	2022	mean		22-Jun	26-Jun	1-Jul	5-Jul
1	Burn	594	773	683	60	18	63	91	99
2	Bale at harvest	433	509	471	54	10	48	81	94
3	Bale-Short clip+Bale	392	418	405	49	8	40	68	86
4	No Treatment	264	499	382	56	1	28	65	90
LSD @ 5% Level		201	122	139	5	6	13	12	5
CV(%)		30	13	18	6	47	18	10	3

TRT#	Treatment	Dry Matter(T/acre)		Protein ¹		RCI ³	
		2021	2022	%DM	%TDN ²	3-Jun	17-Jun
1	Burn	2.5	5.4	4.9	68.0	395	385
2	Bale at harvest	2.1	3.8	5.0	68.3	340	302
3	Bale-Short clip+Bale	1.8	3.3	4.5	68.3	307	317
4	No Treatment	1.4	4.2	6.8	67.7	306	418
LSD @ 5% Level		0.7	1.5	1.1	0.6	NS	76
CV(%)		25	23	13	1	18	13

Experimental Design:RCB/w 4 reps

Harvest Date= 8-9-2021 , 8/22/2022

Kernza variety=MN-Clearwater

Harvested 8/5/2020

Trt#1 Burned 8-11-2020, 8/25/2021

Trt#2 Raked off 8-10-2020, 8/11/2021

Trt#3 Clip-Rake 9-9-2020,9/27/2021 Flail chopped off to 4" ht.

Trt#4 Kernza harvested and residue left on plot

¹ %Protein on Dry Matter basis

² Total digestible nutrients of the dry matter.

³ RCI- Higher number = more relative level of chlorophyll.

Table 22.

2020 & 2021 Hard Fescue Fertility Management

2022 Magnusson Research Farm- Roseau, Mn

2022 Data + 2021 Seed Yield

Added Fertilizer	Seed Yield(#/acre)			Dry Matter tons/ac	% Heading			RCI ¹		Harvest	
	2021	2022	Ave.		31-May	4-Jun	8-Jun	3-Jun	18-Jun	Lodge ²	Ht(in.)
0-40-40	378	730	554	1.32	23	70	95	194	232	1.0	21
40-40-40	670	980	825	1.85	28	53	91	296	298	1.0	26
80-40-40	903	1305	1104	2.28	20	50	89	383	335	1.8	27
120-40-40	854	1486	1170	2.73	15	48	88	437	338	2.0	27
160-40-40	1001	1464	1233	2.68	15	48	86	488	356	2.8	27
LSD @ 5% Level	161	163	125	0.41	8	9	6	18	42	0.8	2
CV(%)	13	9	8	12	25	10	4	3	9	32	4

Experimental Design-RCB w 4 reps

Variety=MN-HD

Harvest Date-7-7-2022 & 6-25-2021

Fertilizer applications -September 27,2021 and Sept 25,2020

¹Relative Chlorophyll Index- higher number=more chlorophyll

²Lodging-1=upright ; 9=flat

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Table 23.

2020 & 2021 Hard Fescue Residue Management

Magnusson Farm-1 Mile SW of Roseau, Mn

2022 data + 2021 Seed Yield

	Seed Yield(#/acre)			Yield Estimate	Dry Matter Tons/ac	Test Weight	Germ ¹	Harvest Ht(in.)	%heading			RCI ²	
	2022	2021	Mean						31-May	4-Jun	8-Jun	3-Jun	18-Jun
1-Desiccate-Burn	596	601	599	575	0.91	19.9	81%	24	19	38	75	510	599
2-Bale after harvest	580	567	574	563	0.91	19.7	89%	24	3	10	60	386	603
3-Bale-Cut/Bale late	438	514	476	475	0.66	16.9	80%	23	5	13	60	463	662
4-No treatment	400	418	409	475	0.69	16.6	68%	24	T	6	53	302	626
LSD @ 5% Level	168	138	135	125	0.19	2.1	NA	NS	9	11	17	67	135
CV(%)	20	16	13	15	14	12	NA	5	81	43	17	10	13

Experimental Design-RCB w 4 reps

Harvested 6-25-2021 & 7/7/2022

¹Germination- Seed germination of cleaned seed by treatment.

Variety=MN-HD

²RCI- Relative chlorophyll index-Higher number =more chlorophyll

Trt#2-3- baled off after harvest 7-9-2020 & 8/3/2021

Trt#3- clipped/raked off 9-15-2020 & 9/15/2021

Trt#1-Gramoxone Max applied 7/30/2020 4pm 81F 42%RH wind s and burned 8-6-2020

Trt#1-Gramoxone Max applied 7/27/2021 3pm 74F 52%RH wind 3-5 ESE mostly sunny burned 8/30/2021

Gramoxone Rate= 1.5pt.+ .25%NIS

Burned 8-30-2021(late because of burn restrictions-drought)

Table 24.

**2021-22 Estimated Straw Value and Cost to Replace Removed Nutrients
After Seed Harvest On 4 Grass Species and Rye**

Crop	Yield Tons/ac.¹	\$\$ Straw Value		Nutrient Removal/Replacement Cost²				
		\$\$/Ton Residue	Total\$\$/acre Residue	\$\$/Ton Nitrogen	\$\$/Ton Phosphorous	\$\$/Ton Potash	\$\$/ton N+P+K	\$\$/acre N+P+K
Kernza Average-	4.3	\$107.00	\$459.00	\$11.52	\$4.00	\$22.03	\$37.55	\$161.47
Per. ryegrass Average-	2.4	\$114.00	\$272.50	\$15.73	\$5.29	\$28.51	\$49.54	\$118.90
Ky.bluegrass Average-	2.1	\$122.00	\$256.00	\$14.33	\$5.29	\$25.92	\$45.54	\$95.63
Hard Fescue Average-	1.1	\$130.00	\$143.00	\$21.22	\$5.94	\$28.94	\$56.11	\$61.72
Rye Average-	1.2	\$60.00	\$80.00	\$10.58	\$4.97	\$11.63	\$27.18	\$32.62

N (Urea) 46-0-0 =**\$.70/#**

P2O5(MAP) 11-52-0= **\$.57/#** (includes-\$.15/# due to N credit)

K2O(Potash) 0-0-60=**\$.53/#**

¹Yield tons/acre- dry matter per acre

²Cost of nutrient replacement when residue is removed.

Table 24a.

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

Field ¹	Harvest year	Location/trial	Prior year ²		Yield ³ Tons/acre	\$\$ Value		Nutrient Removal/Replacement Cost ⁴					Forage Quality of Removed Residue ⁵						
			residue management	Planting Date		Variety	\$\$ Value/ Ton	Total/acre Residue	\$\$ N/Ton	\$\$ P/Ton	\$\$ K/Ton	\$\$ N P K / ton	\$\$ N P K / acre	%Crude Protein	% Ash	Cal/#	Cal/#	% Acid detergent fiber(ADF)	% Total Digestible nutrients
Kernza																			
S	2021	Research farm	1-Burn	9/19	Mn-Clearwater	2.5	\$107	\$268	\$11.52	\$4.00	\$22.03	\$37.55	\$93.88	4.9	4.0	0.7	1.4	43.0	68.0
S	2021	Research farm	2-Bale	9/19	Mn-Clearwater	2.1	\$107	\$225	\$11.52	\$4.00	\$22.03	\$37.55	\$78.86	5.0	4.1	0.7	1.4	41.7	68.3
S	2021	Research farm	3-Bale+clip	9/19	Mn-Clearwater	1.8	\$107	\$193	\$11.52	\$4.00	\$22.03	\$37.55	\$67.59	4.5	3.9	0.7	1.4	42.7	68.3
S	2021	Research farm	4-None	9/19	Mn-Clearwater	1.4	\$107	\$150	\$11.52	\$4.00	\$22.03	\$37.55	\$52.57	6.8	5.0	0.7	1.4	39.3	67.6
S	2022	Research farm	1-Burn	9/19	Mn-Clearwater	5.4	\$107	\$578	\$11.52	\$4.00	\$22.03	\$37.55	\$202.77	4.0	5.3	0.7	1.3	47.0	66.5
S	2022	Research farm	2-Bale	9/19	Mn-Clearwater	3.8	\$107	\$407	\$11.52	\$4.00	\$22.03	\$37.55	\$142.69	3.9	4.9	0.7	1.3	46.5	66.8
S	2022	Research farm	3-Bale+clip	9/19	Mn-Clearwater	3.3	\$107	\$353	\$11.52	\$4.00	\$22.03	\$37.55	\$123.92	4.3	5.4	0.7	1.3	45.9	66.6
S	2022	Research farm	4-None	9/19	Mn-Clearwater	4.2	\$107	\$449	\$11.52	\$4.00	\$22.03	\$37.55	\$157.71	4.6	5.7	0.7	1.3	45.2	66.3
F	2022	Estling farm	Burn	9/19	Mn-Clearwater	5.5	\$107	\$589	\$11.52	\$4.00	\$22.03	\$37.55	\$206.53	8.6	5.8	0.7	1.3	43.6	65.7
Kernza Average-						3.33		\$357					\$77.18	5.2	4.9	0.7	1.3	43.9	67.1
Ryegrass																			
F	2022	Rice Farms		5/2021	Patriot 4	2.3	\$114	\$262	\$15.73	\$5.29	\$28.51	\$49.54	\$113.94	12.6	7.8	0.7	1.3	40.7	63.7
F	2022	Rice Farms		5/2021	Allaire 3	2.7	\$114	\$308	\$15.73	\$5.29	\$28.51	\$49.54	\$133.76	5.1	7.1	0.7	1.3	40.8	65.7
F	2022	Magnusson farms		9/2021	Galactic green	2.0	\$114	\$228	\$15.73	\$5.29	\$28.51	\$49.54	\$99.08	12.8	7.8	0.7	1.3	38.8	63.9
F	2022	Brateng farm		9/2021	Sideways	2.0	\$114	\$228	\$15.73	\$5.29	\$28.51	\$49.54	\$99.08	10.6	7.4	0.7	1.3	42.2	64.2
F	2022	Stanley farm		5/2021	Silver dollar	2.4	\$114	\$274	\$15.73	\$5.29	\$28.51	\$49.54	\$118.90	8.5	10.4	0.6	1.2	40.4	62.6
F	2022	Estling farm		5/2021	Galactic green	2.6	\$114	\$296	\$15.73	\$5.29	\$28.51	\$49.54	\$128.80	9.1	8.1	0.7	1.3	37.7	64.7
Perennial ryegrass Average-						2.33		\$266					\$115.59	10.6	8.9	0.8	1.5	47.4	75.3
Kentucky.bluegrass																			
F	2021	Research farm	Burn	8/2019	Park	1.7	\$122	\$207	\$14.33	\$5.29	\$25.92	\$45.54	\$77.00	9.8	6.1	0.7	1.3	39.0	65.8
F	2022	Research farm	Burn	8/2019	Park	2.0	\$122	\$244	\$14.33	\$5.29	\$25.92	\$45.54	\$91.00	9.1	7.5	0.7	1.3	41.5	64.5
F	2022	Douglas Erickson	Burn	8/2019	Park	3.1	\$122	\$378	\$14.33	\$5.29	\$25.92	\$45.54	\$141.00	7.2	6.6	0.7	1.3	38.1	66.0
F	2022	Wensloff farm	Burn	8/2020	Park	2.0	\$122	\$244	\$14.33	\$5.29	\$25.92	\$45.54	\$91.00	7.9	6.8	0.7	1.3	42.1	65.1
F	2022	Habstritt farm	Burn	8/2019	Park	2.5	\$122	\$305	\$14.33	\$5.29	\$25.92	\$45.54	\$114.00	9.7	5.6	0.7	1.3	39.3	66.2
F	2022	Estling farm	Burn	8/21	Dragon	2.0	\$122	\$244	\$14.33	\$5.29	\$25.92	\$45.54	\$91.00	7.5	6.7	0.7	1.3	44.2	64.9
Kentucky.bluegrass Average-						2.22		\$270					\$100.83	8.5	6.6	0.7	1.3	40.7	65.4
Hard Fescue																			
F	2021	Magnusson farms	None	8/2019	MN-HD	1.30	\$130	\$169	\$21.22	\$5.94	\$28.94	\$56.11	\$73.00	4.4	4.6	0.7	1.3	45.8	67.0
S	2022	Magnusson farms	1-Burn	8/2019	MN-HD	0.91	\$130	\$118	\$21.22	\$5.94	\$28.94	\$56.11	\$51.00	4.9	4.2	0.7	1.3	46.3	67.2
S	2022	Magnusson farms	2-Rake off	8/2019	MN-HD	0.91	\$130	\$118	\$21.22	\$5.94	\$28.94	\$56.11	\$51.00	6.6	4.3	0.7	1.3	43.8	67.1
S	2022	Magnusson farms	3-Rake-clip	8/2019	MN-HD	0.66	\$130	\$86	\$21.22	\$5.94	\$28.94	\$56.11	\$37.00	6.0	4.4	0.7	1.3	43.6	67.2
S	2022	Magnusson farms	4-None	8/2019	MN-HD	0.69	\$130	\$90	\$21.22	\$5.94	\$28.94	\$56.11	\$39.00	6.6	4.2	0.7	1.3	42.7	67.4
Hard Fescue Average-						0.89		116.20					50.20	5.70	4.34	0.70	1.30	44.44	67.18
Rye																			
F	2021	Magnusson farms		9/2020	Serafino	1.3	\$60	\$75	\$10.58	\$4.97	\$11.63	\$27.18	\$34.00	4.2	6.6	0.7	1.3	50.5	64.9
F	2021	Magnusson farms		9/2020	Bono	1.2	\$60	\$69	\$10.58	\$4.97	\$11.63	\$27.18	\$31.00	6.8	5.2	0.7	1.3	46.6	66.2
Spring wheat Average-						1.25		\$72					\$33	5.5	5.9	0.7	1.3	48.6	65.6

Experimental Design: 2-4 samples taken per treatment- no statistical analysis

N (Urea) 46-0-0 = \$.70/#

P2O5(MAP) 11-52-0= \$.57/# (includes \$.15/# due to N credit)

K2O(Potash) 0-0-60= \$.53/#

¹Field-S=small plot treatment;F=production field sampling

²Residue treatment-

1-Paraquat + fall burn

2-Rake off only after harvest

3-Rake off after harvest + clip 3" rake off 4 weeks later

4-No treatment-leave residue in place

³Yield tons/acre- on dry matter per acre basis

⁴Cost of nutrient replacement from baled residue

⁵Forage quality of main dry matter components of residue

Table 25.

**2021-22 Tall Fescue Management/Fertility Trial
Magnusson Research Farm-Roseau,Mn**

Trt#	Residue Treatment	Fertility	Yield		Harvest Ht.(in.)
			#/acre	RCI ¹ 18-Jun	
61	Bale after harvest	1- 120-40-40-10s	812	504	30
62	Bale after harvest	2- 120-40-40-10s	476	451	31
63	Bale after harvest	3- 160-40-40-10s	996	645	31
64	Bale after harvest	4- 160-40-40-10s	650	547	30
51	Bale after harvest+ bale 9/27	1- 120-40-40-10s	716	455	32
52	Bale after harvest+ bale 9/27	2- 120-40-40-10s	547	404	32
53	Bale after harvest+ bale 9/27	3- 160-40-40-10s	1092	611	28
54	Bale after harvest+ bale 9/27	4- 160-40-40-10s	514	485	31
71	Burn after harvest	1- 120-40-40-10s	763	532	32
72	Burn after harvest	2- 120-40-40-10s	358	481	30
73	Burn after harvest	3- 160-40-40-10s	819	646	30
74	Burn after harvest	4- 160-40-40-10s	229	464	31
LSD @ 5% Level			233	121	4
CV(%)			24	16	9

Experimental Design:RCB w/4reps

Variety-Turfway Harvest date=7/27/2022

<u>Residue Management-</u>	<u>Date</u>
Bale after harvest	8/4/2021
Bale after harvest+clip rake	8/4+9/27
Burn after harvest	8/25/2021

<u>Total Fertility-</u>	<u>Added Fertilizer</u>	
	15-Sep	5-May
1- 120-40-40-10s	40-40-40	80-0-0-10s
2- 120-40-40-10s	8-40-40	112-0-0-10s
3- 160-40-40-10s	40-40-40	120-0-0-10s
4- 160-40-40-10s	8-40-40	152-0-0-10s

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Table 26.

**2020 Tall Fescue Establishment Trial
Magnusson Research Farm**

Planting/Establishment Treatment	Seed Yield(#/acre)			RCI ¹ 6/4/22	Ht.(in) Harvest	
	2021	2022	Mean			
Spring wheat 120#/ac & tall fescue 5/21/2020	1317	365	841	211	29	
Spring wheat 75#/acre & tall fescue 5/21/2020	1324	443	883	266	31	
Spring wheat only 120#/ac 5/21--tall fescue 8/20 into stubble	1081	579	830	189	30	
Tall fescue only 5/21/2020	1571	505	1037	219	30	
Tall fescue only 7/17/2020	1159	674	917	258	32	
LSD @ 5% Level		269	198	192	59	2
CV(%)		13	25	13	17	4

Experimental Design-RCB w 4 reps

Tall fescue Variety=Turfway

Tall fescue seeded at 6#/acre

Wheat Variety=Linkert

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

Table 27.

2022 Cover Crop Evaluation
Magnusson Research Farm-Roseau,Mn

						Top Growth			Root Growth			
Wheat stubble-F4						Fresh wt.	Dry wt.	%dry	Fresh wt.	Dry wt.	%dry	
Treat#	Species	Variety	Stand ¹	Vigor ²	%GC ³	Ht(in.)	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre
						10/7	10/10	10/10	10/10	10/10	10/10	10/10
1	Canola	L340PC	6.3	7.7	35	3	6428	748	12	NA	NA	NA
2	Radish	Tapmaster Daikon	5.7	6.3	20	3	2878	365	13	193	27	14
3	Rape	Barsica forage	6.3	6.3	40	3	3358	422	13	NA	NA	NA
4	Turnip	Barkant	7.0	7.7	53	5	8731	988	12	414	58	14
5	Pea	4010 forage field pea	3.0	5.7	10	3	6716	1238	19	NA	NA	NA
6	Crimson clover	VNS	8.3	8.3	22	1	NA	NA	NA	NA	NA	NA
7	Red clover	Ruby	7.0	6.3	22	1	NA	NA	NA	NA	NA	NA
8	Hairy vetch	190VNS	3.7	5.0	25	3	NA	NA	NA	NA	NA	NA
9	Buckwheat*	VNS	8.3	6.3	10	2	384	115	31	NA	NA	NA
10	Flax	Omega	9.0	9.0	40	4	1343	192	15	NA	NA	NA
11	Triticale	Surge	7.0	6.3	37	4	3358	556	17	NA	NA	NA
12	Barley	ND Genesis	7.7	7.7	50	6	4125	633	16	NA	NA	NA
13	Wheat	Linkert	7.0	6.3	37	5	1823	317	17	NA	NA	NA
14	Oats	Deon	8.3	8.3	47	6	4126	691	17	NA	NA	NA
	LSD @5% Level		1.5	1.9	9	1	420	46	3	NA	NA	NA
	CV(%)		13	16	17	13	60	45	9	NA	NA	NA

Experimental design:RCB with 3 reps
 *Frost prior to harvest reduced fresh weight
¹Stand 9/22 - 9= ideal;1=no plants
²Vigor 9/22 -9=best plant vigor;1=poor vigor
³GC 10/7 = %ground cover

											Top Growth			Top Growth			Root Growth			Root Growth		
Fallow -F4											Fresh wt.	Dry wt.	%dry	Fresh wt.	Dry wt.	%dry	Fresh wt.	Dry wt.	%dry	Fresh wt.	Dry wt.	%dry
Treat#	Species	Variety	Stand ¹	Vigor ²	%GC ³	Ht(in.)	10/16	Frost ⁴	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre	#/acre
						10/7	10/16		10/10	10/10	10/10	11/2	11/2	11/2	10/10	10/10	10/10	11/2	11/2	11/2	11/2	11/2
1	Canola	L340PC	8.0	9.0	88	7	8	1.0	11034	1391	12.7	15352	2687	16.9	NA	NA	NA	1660	470	24		
2	Radish	Tapmaster Daikon	8.0	9.0	88	6	7	3.5	10074	1199	11.9	12953	2111	16.2	1545	173	11	5066	528	11		
3	Rape	Barsica forage	7.5	8.0	73	6	6	4.3	7676	1045	13.7	NA	NA	NA	NA	NA	NA	NA	NA	NA		
4	Turnip	Barkant	9.0	9.0	65	7	7	4.5	13720	1641	12.0	14296	2207	15.6	911	144	14.1	3147	432	14		
5	pea	Austrian winter peas	8.0	9.0	55	5	3	1.0	3262	691	21.0	4989	959	19.9	NA	NA	NA	NA	NA	NA		
6	crimson clover	VNS	9.0	9.0	23	1	1	4.0	576	192	33.5	NA	NA	NA	NA	NA	NA	NA	NA	NA		
7	Red clover	Ruby	8.0	7.0	11	1	1	2.5	192	77	35.0	NA	NA	NA	NA	NA	NA	NA	NA	NA		
8	hairy vetch	190VNS	5.5	7.0	45	3	1	1.0	1439	336	21.5	NA	NA	NA	NA	NA	NA	NA	NA	NA		
9	buckwheat	VNS	9.0	9.0	66	9	3	10.0	959	998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		
10	Flax	Omega	9.0	9.0	33	4	5	3.3	1535	307	19.8	1727	575	32.5	NA	NA	NA	NA	NA	NA		
11	Triticale	Surge	7.0	7.5	69	7	8	2.0	7196	1238	17.5	12569	2399	18.8	NA	NA	NA	NA	NA	NA		
12	barley	ND Genesis	9.0	9.0	86	9	9	3.3	9979	1449	14.5	9787	2015	20.3	NA	NA	NA	NA	NA	NA		
13	wheat	Linkert	8.5	7.5	50	7	7	4.3	5660	1017	18.1	7196	1439	19.5	NA	NA	NA	NA	NA	NA		
14	oats	Laker-forage	9.0	9.0	73	9	6	6.5	7484	1238	16.5	6237	1343	21.9	NA	NA	NA	NA	NA	NA		
	LSD @5% Level		1.3	1.1	12	1	1	0.8	2591	345	3.0	3646	768	5.2	NA	NA	NA	NA	NA	NA		
	CV(%)		11	9	14	13	15	15	31	26	8	26	32	18	NA	NA	NA	NA	NA	NA		

Experimental design:RCB with 4 reps
 3 row plots - rows 1' apart x 10'-17' long
 All Planted 9/1/2022
 Handed watered 5 days after planting
¹Stand 9/22 - 9= ideal;1=no plants
²Vigor 9/22 -9=best plant vigor;1=poor vigor
³GC 10/7 = %ground cover
⁴Frost damage 10/16-10=completely desiccated;1=no injury

Soil test 9/15/2022	pH	OM	N1 lb	N2 lb	N-(N1+N2)	P-O ppm	K ppm
Wheat stubble F4	8	3.1	9	6	15	9	99
Fallow F8	7.8	2.8	28	48	76	13	134

Table 28.

Cover Crop Planted Into Perennial Ryegrass Post Harvest Todd Stanley Farm

Location 1

5 miles north of Grygla

Treatment	Fresh wt	Dry wt.	% Dry Matter
	#/acre	#/acre	
Oats with no added N	2687	796	31%
Oats with 40#N added	20149	4030	19%

Location 2

East of Grygla by Todds' house

Crop	Density	Top growth		Root growth	
		Dry wt. #/acre	%Dry	Dry wt. #/acre	%Dry
Turnip	1 plant/ft.	2111	13	1279	9
	1.7 plants/ft.	3358	13	4873	32
Radish	1 plant/ft.	2591	15	6960	46
	1.7 plants/ft.	2591	10	5833	38

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Red Clover Spring Dormant Planted as Cover In Hybrid Rye Production Field Jade Estling Farm-North of Roosevelt,Mn

Mammoth red clover planted with an ATV spin spreader 4/24/2022 into a field of Serafino Rye

10/10/2022 Red clover harvest= **1.57 tons/acre of dry matter.**

Table 29.

2022 P & K Large Plot Fertility Soybean Trial
West Plant-Northern Resources-no yield data obtained in 2022

Soil Samples Taken 10/16/2022

Treatment	P2O5 ppm	K2O ppm	Sulfur #/ac	Zinc ppm	%OM	PH	salt dS/m
Normal(1)	12.2	149	82	0.35	3.7	8.2	0.45
Plus 50(2)	19.5	151	74	0.37	3.7	8.2	0.44
LSD @5% level	10.0	22	67	NS	NS	NS	NS
LSD @10% level	7.5	16	50	0.04	NS	NS	NS
CV(%)	28	6.7	38	7.1	3.2	0.8	21

Tissue Samples 7/6/2022

%N	%P2O5	%K2O	%S	%Ca	%Mg	Zn ppm	Fe ppm	Mn ppm	Cu ppm	Boron ppm
5	0.41	2.5	0.31	1.86	0.79	22.0	389	100	9.3	28.5
5	0.43	2.6	0.32	1.84	0.77	19.0	306	95	8.0	28.8
NS	NS	NS	NS	NS	NS	NS	NS	NS	1.5	NS
NS	0.05	0.44	0.02	0.09	0.07	1.8	81	27	1.1	1.1
6.9	6.9	10.2	3.4	3.1	5.7	5.1	14	17	7.8	2.3

2021 Wheat

Treatment	West				West			Soil Test Levels 9-2021				West Plant		
	Braaten	Plant	Slater	Mean	Braaten	Plant	Mean	West	West	West	West	West	West	RCI
	Yield	Yield	Yield	Yield	Protein	Protein	Protein	P	P	K	K	Harvest	6/15	
Normal(1)	41.9	51.7	61.1	51.6	14.2	17	15.5	14	10	132	133	29	102	
Plus 50(2)	47.4	57.9	63.8	56.4	14.4	17	15.7	19	9	130	135	28.5	140	
LSD @5% level	0.4	NS	NS	5.2	0.1	NS	NS	NS	NS	NS	NS	NS	31	
LSD @10% level	0.3	5.3	NS	3.9	0.1	NS	NS	NS	NS	NS	NS	NS	21	
CV(%)	1	4	10	4	1	6	3	50	13	7	4	7	7	

2020 Soybean Trial

Treatment	West				West		West		West		West		West		West		West	
	Braaten	Plant	Slater	Mean	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant
	Yield(Bu./Acre)	Yield(Bu./Acre)	Yield(Bu./Acre)	Yield(Bu./Acre)	N %	N %	P %	P %	K %	K %	S %	S %	Ca %	Ca %	Mg %	Mg %	Zn ppm	Zn ppm
Normal(1)	30.6	43.5	50.0	41.4	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
Plus 50(2)	34.4	43.9	49.6	42.6	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
LSD @5% level	4	NS	NS	NS	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
LSD @10% level	3	NS	NS	NS	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
CV(%)	6	5	7	4	3	2	6	6	6	6	5	4	6	6	7	2	12	6

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	
	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant
	N #/ac	P ppm	K ppm	S #/ac	B ppm	Zn ppm	Mn ppm	Cu ppm	Mg ppm	Ca ppm	OM %	Salt dS/m	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
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
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
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
CV(%)	9	27	31	18	8	6	41	0	4	8	10	12	16	17	9	9	6	8

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

Treatment	West		West		West		West		West		West		West		West		West	
	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant
	N #/ac	P ppm	K ppm	S #/ac	B ppm	Zn ppm	Mn ppm	Cu ppm	Mg ppm	Ca ppm	OM %	Salt dS/m	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

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

Northern Resources Tissue Tests take 7/20/20

Seeding Date:
 Braaten-- 5/22/2020
 Northern Resources--6/2/2020
 Slater--5/18/2020
 Fertilizer sources:
 Phosphorous(P)- 11-52-0
 Potassium(K) -0-0-60
 Fertilizer application dates:
 Braaten-- 5/22/2020 Slater--5/18/2020
 Northern Resources--6/1/2020

Table 30.

**2022 P & K Long Term Fertility Rotation Trial on Spring Wheat and Soybeans
U of MN, Magnusson Research Farm Roseau, MN**

Wheat 2022

TRT#	Added ¹ P & K	Yield ²		Test Wt.		Harvest		Plant ⁵ pop.
		Bu./acre 2022	#/Bu. 2022	Protein ³ 2022	Ht.(In.) 2022	RCl ⁴ 6/28/22		
1	0-20-0	75.5	60.6	16.6	29	340	1.264	
2	0-40-0	78.1	60.8	16.7	29	381	1.296	
3	0-60-0	76.5	60.5	16.8	29	323	1.296	
4	0-80-0	79.0	60.7	16.8	28	360	1.306	
5	0-100-0	78.2	60.5	16.7	30	360	1.264	
6	0-0-20	74.3	60.7	16.9	28	284	1.264	
7	0-0-40	74.7	60.7	16.8	29	313	1.166	
8	0-0-60	75.0	60.8	16.9	28	251	1.188	
9	0-0-80	77.2	60.7	17.0	28	275	1.264	
10	0-0-100	78.2	61.0	17.1	28	299	1.372	
11	0-20-20	73.7	60.5	16.6	28	332	1.426	
12	0-40-40	78.7	60.7	16.7	29	355	1.296	
13	0-60-60	81.1	60.9	16.7	29	379	1.154	
14	0-80-80	79.3	60.7	16.9	29	338	1.34	
15	0-100-100	77.9	61.1	16.9	29	328	1.296	
16	0-0-0	77.4	60.5	16.7	29	291	1.296	
LSD @ 5% Level		3.9	0.6	0.3	1	77	0.182	
LSD @ 10% Level		3.2	0.5	0.3	1	66	0.15	
CV(%)		3.5	0.6	1.2	3	16	10	

160-0-0 applied to all plots and incorporated in final seedbed prep.

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Soybeans 2022

TRT#	Added ¹ P & K	Yield ²		Test Wt.		Harvest		Plant ⁵ pop.
		Bu./acre 2022	#/Bu. 2022	Protein ³ 2022	Oil ³ 2022	Ht.(In.) 2022	RCl ⁴ 6/28/22	
1	0-20-0	54.1	59.4	40.0	19.7	36	265	0.207
2	0-40-0	47.2	59.9	40.2	19.5	34	282	0.194
3	0-60-0	50.6	59.6	40.2	19.3	37	272	0.177
4	0-80-0	48.8	59.7	39.9	19.4	35	275	0.172
5	0-100-0	52.0	59.2	39.9	19.4	37	264	0.191
6	0-0-20	48.7	59.6	39.7	19.6	35	263	0.161
7	0-0-40	49.9	59.2	39.3	20.0	35	255	0.193
8	0-0-60	50.2	59.0	39.3	20.0	34	268	0.188
9	0-0-80	47.1	59.3	39.6	19.8	34	262	0.185
10	0-0-100	51.1	58.9	39.5	20.2	34	267	0.177
11	0-20-20	57.5	59.2	40.2	19.7	36	276	0.194
12	0-40-40	55.4	59.4	39.6	19.8	37	280	0.172
13	0-60-60	53.8	59.3	39.1	19.6	36	267	0.191
14	0-80-80	53.9	59.5	38.9	19.9	35	267	0.158
15	0-100-100	57.8	59.6	39.7	19.5	36	251	0.18
16	0-0-0	52.1	59.0	39.7	20.1	35	270	0.204
LSD @ 5% Level		6.7	0.8	0.9	0.5	2	37	0.0639
LSD @ 10% Level		6.1	0.7	0.8	0.4	1	30	0.058
CV(%)		9	0.9	1.7	1.9	4	10	12

Experimental Design: RCB with 4 reps

All plots us best management practices(BPM)

Soybean variety - AG005xF2 seeded at 1.5 units/ac; 210,000 PLS/ac on 6/9/2022.

Linkert wheat seeded @ 120#/acre 5/28/2022.

¹Fertilizer added- 0-46-0 super phosphate and 0-0-60 potash used for P and K sources.

²Yield-Bushels per acre corrected to 12% moisture for wheat and 13% moisture for soybean.

³Protein and Oil -on dry matter basis.

⁴RCl- Relative chlorophyll index-higher number = more chlorophyll.

⁵Plant pop- Plant count in Millions per acre on 6-22-2022.

Plot size= 6' x 15'

Harvest area= 5' x 10'

Soil Type-Borup silt loam(2021 wheat) Zippel very fine clay loam(2021 soybeans)

Baseline 5/7/2019	PH	%	Olsen P	NH4OAc-K	SO4-S	Zn	nitrates	Sol
Soil tests-0-6"		OM	ppm	ppm	#/ac	ppm	#/acre	salts
F7SE(wheat in 2019)	8.2	2.8	6	154	14	0.27	9	0.23
F7NW(soybean in 2019)	7.8	2.8	23	166	34	0.38	NA	0.4

Table 32.

**2022 P & K Long Term Fertility Rotation Trial on Spring Wheat and Soybeans
U of MN, Magnusson Research Farm Roseau, MN**

Wheat 2019-22

TRT#	P & K	Yield Bu./acre ²		Test Wt./Bu.				Protein ³				Soil Test Results ⁴		Tissue Test Results ⁵		Soil								
		2019	2021	2019	2020	2021	2022	2019	2020	2021	2022	P	K	P	K	P	K	S	Zn	%OM	PH	Salts		
		2020	2022	2020	2021	2022	2020	2021	2022	2020	2021	2022	2020	2021	2020	2021	2020	2021	2022	2020	2021	2022		
1	0-20-0	85.0	73.0	72.6	75.5	60.3	63.0	61.9	60.6	15.3	14.7	16.9	16.6	5.5	130	0.36	2.9	15.5	94	21	0.28	2.9	8.1	0.23
2	0-40-0	86.3	75.8	79.6	78.1	60.3	62.3	62.0	60.8	15.3	14.6	16.8	16.7	8.5	125	0.39	3.1	15.8	94	27	0.29	2.6	8.2	0.24
3	0-60-0	87.3	72.8	78.6	76.5	60.2	62.3	62.0	60.5	15.1	14.5	17.0	16.8	9.5	125	0.41	2.8	23.8	91	19	0.30	3.0	8.1	0.22
4	0-80-0	85.3	69.8	80.0	79.0	60.3	62.7	62.0	60.7	15.1	14.3	16.6	16.8	12.5	128	0.45	3.0	29.3	94	25	0.30	2.9	8.0	0.24
5	0-100-0	92.8	67.8	79.0	78.2	60.2	62.7	61.4	60.5	15.2	14.0	17.0	16.7	16.8	119	0.45	2.7	26.5	107	18	0.34	2.6	8.1	0.21
6	0-0-20	81.3	70.5	64.3	74.3	60.0	62.1	62.2	60.7	15.4	14.4	17.0	16.9	4.0	121	0.33	3.0	10.5	99	19	0.27	3.1	8.1	0.22
7	0-0-40	81.5	69.3	63.2	74.7	60.0	62.9	61.9	60.7	15.4	14.6	17.3	16.8	5.0	127	0.32	3.3	12.8	109	21	0.28	3.1	8.1	0.23
8	0-0-60	83.3	69.5	60.3	75.0	60.0	63.1	62.1	60.8	15.5	14.5	17.3	16.9	4.5	132	0.32	3.6	10.5	114	23	0.27	2.3	8.1	0.24
9	0-0-80	81.3	70.3	60.7	77.2	60.3	62.4	62.3	60.7	15.7	14.9	17.4	17.0	4.8	147	0.3	3.7	11.3	114	20	0.29	2.4	8.1	0.22
10	0-0-100	82.5	71.3	59.0	78.2	60.1	63.1	62.2	61.0	15.7	14.5	17.1	17.1	3.8	136	0.32	4.0	11.0	117	38	0.29	2.4	8.0	0.25
11	0-20-20	89.0	70.5	75.9	73.7	60.1	63.0	62.2	60.5	15.3	14.5	17.1	16.6	6.0	126	0.35	3.2	12.0	86	19	0.26	2.4	8.1	0.21
12	0-40-40	86.5	74.8	80.5	78.7	60.1	62.1	61.8	60.7	15.2	14.2	16.8	16.7	10.8	135	0.39	3.3	19.5	97	21	0.28	2.5	8.1	0.22
13	0-60-60	85.3	73.3	82.4	81.1	60.2	61.7	62.2	60.9	15.1	14.4	17.1	16.7	12.5	125	0.43	3.5	21.5	93	21	0.27	2.4	8.1	0.22
14	0-80-80	77.5	76.0	82.8	79.3	60.0	62.8	62.3	60.7	15.3	14.6	17.1	16.9	19.5	130	0.43	3.4	22.5	98	21	0.29	2.9	8.1	0.22
15	0-100-100	87.8	74.0	84.8	77.9	60.3	62.6	62.0	61.1	15.2	14.4	17.1	16.9	19.8	139	0.44	3.5	27.3	104	18	0.30	2.4	8.0	0.22
16	0-0-0	82.3	67.0	60.0	77.4	60.2	62.6	61.7	60.5	15.3	14.7	17.0	16.7	3.7	120	0.33	3.0	12.3	95	21	0.26	2.5	8.1	0.20
LSD @ 5% Level		8.6	7.4	7	3.9	0.3	1.3	0.6	0.4	0.2	0.7	0.7	0.3	3.8	12	0.05	0.3	4.1	20.1	15.1	0.03	0.7	0.2	0.1
LSD @ 10% Level		7.2	6.2	5.8	3.2	0.2	1.1	0.5	0.3	0.2	0.5	0.6	0.3	3.1	10	0.04	0.2	3.5	16.7	12.5	0.03	0.6	0.2	0.1
CV(%)		7.2	7.2	6.7	3.5	0.3	1.5	0.6	0.5	1.1	3.2	3.0	1.2	28	6	9	7	16	14	49	8	17	1.3	14

Linkert wheat seeded @ 120#/acre 5/11/2019
160-0-0 applied and incorporated in final seedbed prep.

2022

TRT#	P & K	Tissue											Ht. (in.)			RCI ⁶			Plant Pop. (million)			
		B	Ca	Ch	Cu	Phos	I	Mg	Mn	N	P	K	Na	S	Zn	2019	2021	2022		7/20/20	6/15/21	6/15/22
1	0-20-0	3.50	0.46	0.20	8.30	15.30	273	0.52	56	5.99	0.53	3.78	0.11	0.31	20	30	29	29	493	241	340	1.264
2	0-40-0	4.30	0.45	0.36	7.80	12.00	282	0.49	58	6.00	0.53	3.95	0.09	0.33	20	30	29	29	491	253	381	1.296
3	0-60-0	2.80	0.39	0.24	8.00	11.00	258	0.53	52	6.20	0.52	3.73	0.11	0.35	19	30	31	29	411	263	323	1.296
4	0-80-0	3.30	0.42	0.21	8.00	16.80	251	0.54	53	6.20	0.57	3.65	0.11	0.36	19	30	31	28	435	221	360	1.306
5	0-100-0	3.00	0.44	0.23	8.30	14.80	259	0.51	55	6.20	0.59	4.18	0.05	0.38	20	29	31	30	410	236	360	1.264
6	0-0-20	2.80	0.42	0.71	7.50	11.30	279	0.45	59	5.80	0.50	4.08	0.03	0.30	20	30	32	28	459	296	284	1.264
7	0-0-40	3.00	0.42	0.80	8.30	9.50	304	0.47	56	5.70	0.50	4.33	0.03	0.32	21	29	33	29	421	295	313	1.166
8	0-0-60	3.00	0.39	0.88	7.80	6.80	279	0.44	55	5.70	0.48	4.50	0.02	0.31	20	30	34	28	373	348	251	1.188
9	0-0-80	3.00	0.39	0.92	7.80	8.50	277	0.44	59	5.70	0.49	4.45	0.03	0.31	21	30	31	28	404	268	275	1.264
10	0-0-100	3.00	0.42	0.93	7.50	10.30	272	0.41	60	5.60	0.49	4.38	0.02	0.29	22	30	32	28	439	303	299	1.372
11	0-20-20	3.30	0.42	0.76	8.00	8.30	256	0.48	56	5.80	0.48	3.95	0.06	0.32	20	30	30	28	391	289	332	1.426
12	0-40-40	3.00	0.41	0.80	7.80	11.80	255	0.48	58	5.90	0.53	4.30	0.04	0.33	20	30	30	29	428	219	355	1.296
13	0-60-60	3.00	0.42	0.84	7.50	13.00	258	0.46	59	5.90	0.54	4.10	0.03	0.33	19	30	29	29	415	259	379	1.154
14	0-80-80	3.30	0.38	0.83	7.50	9.80	273	0.44	58	6.00	0.54	4.30	0.04	0.36	19	30	32	29	472	267	338	1.34
15	0-100-100	4.30	0.40	0.86	7.80	13.50	260	0.43	56	5.90	0.57	4.45	0.04	0.35	19	29	30	29	408	308	328	1.296
16	0-0-0	3.80	0.49	0.15	7.80	18.30	269	0.50	57	5.90	0.53	3.88	0.06	0.28	23	31	29	29	395	245	291	1.296
LSD @ 5% Level		0.95	0.06	0.14	0.96	6.13	35	0.06	6	0.15	0.05	0.39	0.06	0.03	2	1	4	1	59	88	77	0.182
LSD @ 10% Level		0.80	0.05	0.11	0.79	5.09	30	0.05	5	0.11	0.04	0.34	0.05	0.03	1	1	3	1	50	78	66	0.15
CV(%)		20.6	10	16	8.6	6.2	9	9	8	2	36	6.6	82	6.5	5.5	3	9	3	10	24	16	16

Table 33.

2021-2 Rye and Winter Wheat P and K Fertility
Magnusson Research farm

TRT#	Crop	Fertilizer Added	Yield Bu./acre ¹			Test wt.		RCI ³		5/11/22		6/17		Harvest	
			2022	2021	Average	Protein	#/Bu.	Ergot ²	6/3	6/17	Vigor ⁴	%stand	color ⁵	lodging ⁶	Ht(in.)
1	Jerry-ww	0	65.8	83	74.4	15.1	60.5	0.0	349	614	2.8	76	8	3.8	40
2	Jerry-ww	0-20-20	63.1	83	73.1	15.6	60.2	0.0	326	604	2.3	68	8	4.0	38
3	Jerry-ww	0-40-40	64.8	82	73.4	15.3	60.6	0.0	305	635	2.5	74	8	3.8	38
4	Jerry-ww	0-60-60	65.0	88	76.5	15.1	60.7	0.0	342	680	2.8	73	8	4.0	39
5	Jerry-ww	0-80-80	64.3	85	74.7	15.1	60.6	0.0	315	640	2.8	76	8	4.3	38
6	Rymin rye	0	97.7	85	91.4	16.0	55.1	1.5	561	468	3.8	88	6	4.5	53
7	Rymin rye	0-20-20	94.8	88	91.4	16.1	54.8	1.6	532	497	3.5	90	6	4.3	53
8	Rymin rye	0-40-40	95.8	86	90.9	16.1	54.6	2.0	571	450	4.0	93	6	4.8	51
9	Rymin rye	0-60-60	93.4	91	92.2	16.0	55.0	1.8	591	422	3.8	85	6	4.8	51
10	Rymin rye	0-80-80	91.9	83	87.5	16.2	54.8	2.3	623	395	4.0	91	6	5.8	52
11	KWS Serafino rye	0	151.3	123	137.2	13.4	56.5	0.4	544	570	3.8	89	7	1.3	51
12	KWS Serafino rye	0-20-20	155.5	133	144.3	13.2	55.9	0.4	541	713	3.5	88	7	1.0	49
13	KWS Serafino rye	0-40-40	156.7	137	146.9	13.3	56.5	0.4	525	671	3.8	88	7	1.3	52
14	KWS Serafino rye	0-60-60	159.0	139	149.0	12.9	56.4	0.1	623	642	4.0	90	7	1.5	52
15	KWS Serafino rye	0-80-80	160.4	140	150.2	13.1	56.6	0.3	520	615	3.5	83	7	1.0	51
LSD @5% level			13	10	9.8	0.9	0.7	0.9	81	92	0.8	12	0	1.8	3
CV(%)			8.7	7	7	4.5	0.85	84	11	11	16	10	0	39	5

TRT#	Crop	Fertilizer Added	soil test post harvest 9/14/2022																
			PH	OM	N-ppm	P-O ppm	K ppm	Ca ppm	Mg ppm	Na	S	Zn	salts	Cu	B	Fe	Mn	CEC	%CEC
1	Jerry-ww	0	8.2	3.3	8	6.3	93	2401	767	25	19	0.25	0.22	0.33	0.61	8.1	0.96	18.7	0.53
2	Jerry-ww	0-20-20	8.1	3.2	7	7.0	91	2195	708	19	20	0.22	0.20	0.29	0.54	7.2	0.85	17.2	0.58
3	Jerry-ww	0-40-40	8.1	3.2	7	7.5	96	2237	730	21	18	0.23	0.20	0.31	0.55	8.0	0.91	17.6	0.33
4	Jerry-ww	0-60-60	8.0	3.3	10	11.5	109	2381	746	22	18	0.27	0.18	0.35	0.61	9.1	1.00	18.5	0.35
5	Jerry-ww	0-80-80	8.1	3.2	9	12.3	97	2311	731	23	20	0.24	0.21	0.30	0.53	8.1	0.86	18.0	0.43
6	Rymin rye	0	8.0	3.1	11	4.3	92	2238	700	21	18	0.22	0.21	0.30	0.53	8.4	1.08	17.4	0.45
7	Rymin rye	0-20-20	8.1	3.1	11	5.0	90	2249	713	21	17	0.22	0.21	0.30	0.54	7.9	1.04	17.5	0.33
8	Rymin rye	0-40-40	8.0	3.2	10	6.0	93	2168	696	17	18	0.25	0.19	0.32	0.56	8.6	1.06	17.0	0.43
9	Rymin rye	0-60-60	8.0	3.1	10	5.0	92	2356	713	18	18	0.24	0.17	0.33	0.56	8.7	1.07	18.0	0.55
10	Rymin rye	0-80-80	7.9	3.1	13	8.5	92	2197	665	18	18	0.26	0.18	0.32	0.55	8.6	1.00	16.8	0.25
11	KWS Serafino rye	0	8.0	3.1	10	4.3	84	2190	657	19	19	0.24	0.19	0.31	0.52	8.8	1.20	16.7	0.30
12	KWS Serafino rye	0-20-20	7.9	3.3	11	7.0	87	2224	683	18	18	0.24	0.20	0.31	0.54	8.1	0.90	17.1	0.20
13	KWS Serafino rye	0-40-40	7.9	3.3	10	6.0	90	2238	704	22	19	0.26	0.19	0.33	0.59	9.0	1.08	17.4	0.33
14	KWS Serafino rye	0-60-60	8.0	3.3	11	9.0	88	2134	677	19	18	0.23	0.21	0.29	0.52	8.0	0.87	16.6	0.23
15	KWS Serafino rye	0-80-80	8.0	3.1	8	8.0	82	2173	687	19	19	0.25	0.19	0.31	0.54	8.6	0.98	16.9	0.28
LSD @5% level			0.1	0.3	3	3.5	11	263	98	6	3	0.05	0.05	0.04	0.08	1.6	0.15	2.0	0.28
CV(%)			1	7	22	34	8	8	10	22	12	14	17	9	10	14	11	8	53

TRT#	Crop	Fertilizer Added	Tissue Sample 6/16/2022															
			%N	%P	%K	%S	%Ca	%Mg	Zn-ppm	Fe-ppm	Mn-ppm	Cu-ppm	B-ppm					
1	Jerry-ww	0	5.0	0.32	1.85	0.38	0.37	0.33	17	111	43	5.0	4.3					
2	Jerry-ww	0-20-20	5.0	0.34	2.02	0.37	0.36	0.30	18	112	43	5.5	4.3					
3	Jerry-ww	0-40-40	5.1	0.34	1.93	0.40	0.40	0.32	17	122	43	5.3	3.8					
4	Jerry-ww	0-60-60	5.0	0.35	2.03	0.35	0.39	0.32	16	117	44	5.8	4.0					
5	Jerry-ww	0-80-80	5.1	0.36	2.03	0.40	0.38	0.32	16	120	44	5.5	4.0					
6	Rymin rye	0	4.4	0.23	1.08	0.36	1.35	0.70	14	117	57	6.8	8.0					
7	Rymin rye	0-20-20	4.6	0.24	1.04	0.40	1.36	0.74	15	115	62	7.0	8.3					
8	Rymin rye	0-40-40	4.6	0.25	1.05	0.38	1.39	0.72	15	121	54	7.0	7.5					
9	Rymin rye	0-60-60	4.5	0.25	1.09	0.38	1.39	0.74	14	124	55	7.0	8.0					
10	Rymin rye	0-80-80	4.6	0.25	1.06	0.38	1.35	0.67	14	120	53	6.8	8.0					
11	KWS Serafino rye	0	4.8	0.27	1.28	0.44	1.26	0.58	15	123	61	8.5	9.5					
12	KWS Serafino rye	0-20-20	5.1	0.28	1.21	0.45	1.31	0.65	16	138	54	9.0	7.3					
13	KWS Serafino rye	0-40-40	5.0	0.27	1.07	0.45	1.31	0.62	15	124	61	8.5	8.0					
14	KWS Serafino rye	0-60-60	4.9	0.27	1.1	0.43	1.32	0.62	15	126	57	8.5	7.5					
15	KWS Serafino rye	0-80-80	4.9	0.28	1.13	0.46	1.31	0.63	16	130	60	9.0	8.0					
LSD @5% level			0.15	0.02	0.17	0.05	0.19	0.10	2	13	10	1.4	1.2					
CV(%)			2	6	9	9	13	13	8	8	13	14	13					

Experimental Design=RCB w 4 reps

Fertilizer applied prior to planting 9/10/2021 and planted 9/15/2021.

Fertility source= 11-52-0 and 0-0-60

All remaining nitrogen applied in spring

120-0-0 hand applied to all plots 5/19/2022

¹-Yield adjusted to 12% moisture²Ergot-visual estimate of ergot-1=.1%ergot³RCI-Relative chlorophyll index-higher number =more relative amounts of chlorophyll⁴Vigor-1=poor plant vigor;5=good vigor⁵color-1=light green;9=dark green⁶lodging-1=no lodging;9=flat

Past crop=Soybeans in 2020

Soil test 10/2021

0-6"		6-24"		Total	Soil test depth = 0-6"					
nitrate	nitrate	nitrate	P	K	s	zn	%OM	PH	%cce	
4	6	10	7	106	16	0.23	2.1	8.1	0.3	

Table 34.

2022 Hybrid Rye Nitrogen Rate Trial Magnusson Farms

TRT#	Nitrogen Rate ¹	Bu./acre Yield ²			3 year Average	Test wt. #/Bu.	Ergot ³	RCI ⁴		Color ⁵	Harvest Ht(in.)
		2022	2021	2020				6/3/22	6/15/22		
1	0	36.8	50.9	29.2	39	53.9	1.7	157	243	1.8	44
2	40-0-0	76.9	78.3	69.7	75	54.2	0.7	285	427	5.0	48
3	80-0-0	95.5	93.3	83.0	90	54.2	0.2	378	528	6.0	50
4	120-0-0	89.1	103.8	85.7	93	53.7	0.7	382	602	7.8	48
5	160-0-0	83.5	103.9	86.2	91	53.4	1.2	363	610	7.0	50
6	200-0-0	91.6	101.3	94.1	96	53.7	0.5	406	618	7.8	50
7	200-0-0+PGR ^a	94.4	NA	NA	NA	52.6	1.0	395	664	8.0	46
8	120-0-0-30S	93.4	103.7	90.8	96	53.7	0.5	386	613	7.5	51
LSD @5% level		15	13.1	9.8	9	0.6	1.2	71	66	0.9	3
CV(%)		12.4	9.7	8	8	0.8	95	14	8	9	4

Aerial spring application adjacent to plot area=70 bushels/acre

50# N added to aerial application=91 bushels/acre

TRT#	Nitrogen Rate ¹	Tissue Sample- flag leaf Early heading 6-7-2021									
		%N	%P	%K	%S	%Ca	%Mg	Zn-ppm	Mn-ppm	Cu-ppm	B-ppm
1	0	4.6	0.22	1.05	0.35	0.75	0.48	14	38	8.3	6.3
2	40-0-0	4.6	0.24	1.06	0.35	0.89	0.53	15	42	8.3	7.3
3	80-0-0	4.5	0.23	1.13	0.33	0.81	0.52	16	37	8.3	7.3
4	120-0-0	5.1	0.24	1.02	0.38	0.93	0.56	16	43	8.5	6.5
5	160-0-0	5.0	0.25	1.06	0.39	0.81	0.50	15	42	9.0	6.5
6	200-0-0	5.2	0.25	1.03	0.41	1.03	0.57	16	49	9.0	7.0
7	200-0-0+PGR ^a	4.9	0.23	0.96	0.38	0.99	0.54	15	48	8.3	7.5
8	120-0-0-30S	4.8	0.24	1.19	0.56	0.98	0.65	19	40	9.5	6.8
LSD @5% level		0.6	0.02	0.17	0.07	0.23	0.12	2	9	1	NS
CV(%)		9	7	11	12	17	15	9	15	8	20

Experimental Design=RCB w 4 reps Variety=Tayo

Nitrogen Fertilizer applications made 5/10/2022

¹Nitrogen Rate-All N rates are #N/acre- urea source. Trt#8 has 30# sulfur(AMS) added. Trt#7 had 12oz.

^aPalisade 1EC 12 oz./ac + .25%NIS applied 5/27/2022 sunny,65F ENE 5-8mph-feeks 4-12" G height

²Yield adjusted to 12% moisture. Magnusson Farms in 2021 as well and Amundson farms 2020.

Variety=Tayo-2022 ; Serafino 2021; Brassetto 2020

³Ergot-visual rating of harvested seed. 1=0.1%ergot.

⁴RCI Relative chlorophyll index- Higher number means higher level of chlorophyll

⁵Color-visual rating: 9= dark green;1=light green

Past crop-canola in 2021.

Soil test- 10/2021

0-6"	6-24"	Soil test depth = 0-6"				
nitrate	nitrate	P	K	%OM	PH	%cce
13	NA	4L	145M	3.4L	7.7	.4VL

Table 35.

**2021-2 Rye Micronutrient Application For Ergot Reduction
Magnusson Research Farm**

Trt ¹	Treatment/Formulation	Application		Yield Bu/acre ²		Test Wt		%Stand ⁴	Vigor ⁵	RCI ⁶		Color ⁷	Harvest
		Timing	Rate/ac	2022	2021	#/bu.	Ergot ³			5/11/22	6/3/22		
1	No Treat	-----	-----	141.7	92.7	56.7	1.4	89	4.5	578	616	7.5	53
2	3-0-0-6%Mn 13%	5-Oct	2pt	147.7	91.1	56.7	0.9	92	4.5	548	668	7.5	53
3	MnSO ₄ 27%	5-Oct	4#	146.0	91.0	56.8	1.0	91	4.8	598	608	7.5	53
4	Badge SC 2.27#/gal	22-May	2pt	145.9	-----	56.6	1.1	93	4.8	589	606	7.5	53
LSD @5% level				7(ns)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)				3	7	0.3	36	6	11	10	14	0	3

6-6-2022 boot stage whole plant tissue samples													
Treatment	Application		B	Ca	Cu	Fe	Mg	Mn	Total-N	P	K	S	Zn
	Timing	Rate/ac	ppm	%	ppm	ppm	%	ppm	%	%	%	%	ppm
No Treat	-----	-----	9.5	0.56	9.8	82	0.34	49.3	4.8	0.29	1.7	0.31	14.8
3-0-0-6%Mn	5-Oct	2pt	9.5	0.57	9.0	84	0.35	47.3	4.9	0.29	1.7	0.31	14.0
MnSO ₄	5-Oct	4#	9.3	0.51	9.8	80	0.32	45.6	4.8	0.27	1.6	0.29	13.8
Badge SC	22-May	2pt	8.5	0.49	13.3	75	0.3	42.5	4.9	0.26	1.5	0.28	12.8
LSD @5% level			NS	0.08	1.7	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)			18	10	11	11	11	11	2	10	11	12	12

Experimental Design=RCB w 4 reps Variety=Serafino

120-50-50 applied to all plots 5/19/22

¹Trt= 2&3 applied 10/5/2022 after emergence

Badge applied 5/22 rye 5-7" tillering 7pm 57F 8 mph wnw 31%RH clear full sun

Badge SC copper hydroxide + copper oxychloride 2.27# metallic copper/gal.

²Bu./Ac.= Clean seed yield @13% moisture. Border plot yield with no added micro nutrients and 120-0-0=146.3 bu./acre

³Ergot=Visual estimate of ergot-1=0.1% ergot estimate

⁴%Stand=Visual % rating of full stand

⁵Vigor=5= best;1=least

⁶RCI=Relative chlorophyll index- higher number = more relative amount of chlorophyll.

⁷Color=9-dark green;1=light green

Table 36.

2022 Rye Herbicide Screen Magnusson Farm-Roseau,Mn

Trt#	Treatment	Adjuvant	Rate	2022	2021	2020	Ergot	Harvest Ht(in.)
				Bu./ac	Bu./ac	bu./ac		
1	No Treatment		-----	85	101	73.4	0.5	48
2	Bison+MCPE		1pt+.25pt	87	91	66.3	0.5	51
3	MCPA+Moxy		.75pt+1pt	82	99	68.7	0.6	47
4	Huskie		13oz.	95	103	67.2	0.5	48
5	Achieve	.5%NIS	1pt	74	101	-----	0.5	48
6	PowerFlex	.5%NIS	3.5oz	77	100	-----	0.5	49
7	Perfect Match+MCPE		1pt+.5pt	84	-----	-----	0.5	48
LSD @5% level				19	NS	NS	NS	2
CV(%)				16	9.6	12	122	3

Experimental Design=RCB w 4 reps Variety=Tayo

All applied 5/26/2022 62F wind NE 3-6 GH-8"
w/10' bike sprayer @ 28psi and 12gpa
All plot yields corrected to 12% moisture

Herbicide Treatments-

Trade name -- Common name(#/Ga.)

Bison mcpa-ester2#+bromoxynil 2#

MCPE mcpa-ester 3.7#

MCPA mcpa-amine 3.7#

Moxy bromoxynil 2#

PowerFlex HL-- pyroxsulam

Huskie pyrasulfotole .31#+bromoxynil 1.75#

Achieve SC --tralkoxydim 3.3#

Perfect Match--.11# Pyroxsulam +.75# Clopyralid+.75#Fluoxypyr

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Table 37.

2021-2 Rye Seed Treatment Trial Magnusson Research Farm

Seed treatments-	Yield ¹	test wt	Harvest	Ergot(%) ²	6/3/22	5/15/2022	9/28/2021		
	Bu/acre	#/Bu	Ht.(in.)		RCI ³	vigor ⁴	%stand	pl/ft2	plants/acre
1=untreated	140	55.4	52	0.25	521	4.4	94	7.5	327
2=Seamac+ZN+CU	133	54.7	51	0.25	537	4.6	97	6.6	288
3=Seamac+MN+ZN+CU +F4019-4	137	55.5	51	0.33	526	4.8	95	7.6	331
4=F-4019-4	141	55.2	51	0.22	541	5.3	97	5.8	253
5=Semac + 4019-4	136	55.3	51	0.18	531	4.5	97	6.8	296
LSD @5% level	NS	NS	NS	NS	NS	NS	NS	1.4	61
LSD @10% level	NS	0.7	NS	NS	NS	1.8	NS	1.2	53
CV(%)	10	1	2	53	10	14	3	13	13

Experimental Design=RCB w 4reps

¹Yield=Bushels per acre corrected to 12%moisture

²Ergot=visual rating of ergot % in harvested plot sample

³RCI=Relative chlorophyll index-higher number = higher level of chlorophyll

⁴Vigor: 1=poor; 5=best

Seeding rate=40#/acre

120-50-50 applied 5/19/22 to all plots

Planting date=9-15-2021

Table 38.

Armyworm Moth Trapping Project in Roseau County Summary Report - 2021 & 2022

True Armyworm (*Mythimna unipuncta*) moth capture at six locations in Roseau County in 2022

Date	Location						Total
	1	2	3	4	5	6	
28-May	0	12	0	6	0	*	18
29-May	3	0	0	0	1	*	4
31-May	14	3	0	0	0	*	17
1-Jun	0	0	0	0	10	*	10
12-Jun	19	8	9	0	11	0	47
14-Jun	5	0	1	2	17	6	31
18-Jun	10	2	5	0	4	0	21
20-Jun	10	5	1	0	9	8	33
26-Jun	0	15	1	7	7	0	30
2-Jul	19	18	6	10	0	0	53
4-Jul	0	0	0	0	22	0	22
8-Jul	0	0	0	0	0	10	10
11-Jul	13	0	0	0	0	2	15
Total	93	63	23	25	81	26	311

*Armyworm trap placed in the field on June 1, 2022

This armyworm moth trapping project will continue in 2023.

In 2023, perennial ryegrass fields will be the focus as in the last two years, armyworm trapping indicated that moth flights into northern MN during May June and July seem to have a preference for perennial ryegrass field compared to other grass crops.

The six armyworm moth trapping locations in 2022:

Location 1: Dieter Township, Section 34, SE quarter. Trap placed in the middle of a perennial ryegrass field.

Location 2: Jadis Township, Section 15, SW quarter. Trap placed in the middle of a perennial ryegrass field.

Location 3: Jadis Township, Section 9, SE quarter. Trap placed in the border of a hybrid rye and a perennial ryegrass field.

Location 4: Jadis Township, Section 5, SW quarter. Trap placed in the border of a Ky. bluegrass and a per. ryegrass field.

Location 5: Laona Township, Section 10, NE quarter. Trap was in a field boundary of two perennial ryegrass seed field.

Location 6: Jadis Addition, Section 32, SE quarter. Trap was in middle of a Kentucky bluegrass seed field.

In 2022, this armyworm moth trapping project documented four flights with moth captures that averaged over 3 moths/night.

The calendar dates and the number of moths collected were:

- May 28 - June 1 = 49
- June 12-14 = 78
- June 18-20 = 54
- July 2-4 = 53

Armyworm moth capture at four location in Roseau County in 2021

Date	Location				Total
	1	2	3	4	
18-May	4	0	0	0	4
21-May	14	10	0	2	26
23-May	15	11	9	1	36
25-May	7	0	0	4	11
29-May	8	2	0	3	13
31-May	1	0	3	0	4
3-Jun	2	0	0	1	3
11-Jun	0	0	1	1	2
13-Jun	4	4	0	2	10
15-Jun	4 + 2*	3 + 2*	7	5	19
17-Jun	2	2 + 1*	0	3	7
20-Jun	0	1	4	0	5
24-Jun	0	0	0	0	0
Total	61	33	24	22	140

*Spotted cutworm moth

Thirty eight moths were captured in a trap at the U of MN-
Magnusson Research Farm from July 22-25.

The four armyworm moth trapping locations in 2021:

Location 1: Jadis Township, Section 5, SW quarter.

Trap placed in the middle of ryegrass field.

Location 2: Jadis Township, Section 9, NE quarter. Trap in a field border
between a Kentucky bluegrass and perennial ryegrass seed field.

Location 3: Laona Township, Section 10, NE quarter.

Trap was in field a boundary of spring wheat and a perennial ryegrass seed field.

Location 4: Jadis Addition, Section 32, SE quarter.

Trap was in middle of a Kentucky bluegrass seed field.