

Research Report on the CFANS Magnusson Research Farm
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The College of Food, Agricultural, and Natural Resource Sciences Magnusson Research Farm continues to be the major location in the region for numerous research and outreach activities.



The Magnusson Research Farm is comprised of forty acres of land located 3.2 miles from Roseau, MN of which over half is devoted to research plot area. The remainder of the land is occupied by two buildings which house field and plot equipment, offices, and facilities; a dryer; and alleys that allow access to the plot areas. The Magnusson Research Farm serves as the base of research operations and its research scientists (Donn Vellekson and Dave Grafstrom) provide management

and support for the trials. On average, the Magnusson Research Farm staff manage over 3,600 research plots per year (range from 3,063 – 4,498 plots per year, see attached summaries). The research staff arranges for the on and off site locations of the trials and handles or assists with site preparation, seeding, treatment applications, note taking, and/or harvesting in collaboration with the project leaders.

Varietal trials of the important agronomic species in production in the area (wheat, barley, oat, canola and soybean) and potential new crops for production (Kernza[®], pennycress, camelina, faba bean, pea) are conducted on the Magnusson Research farm or located nearby at on-farm sites with the data being available through the Varietal Trials Publication. More importantly, the Magnusson Research Farm is critical to the spring wheat, barley, oat, and soybean breeding projects for the development and release of important new cultivars. The Magnusson Research Farm offers a unique environment for testing with different soil types, high soil pH, and different disease pressures compared to sites in Minnesota and the Red River Valley. For example, over the past 5 years, the spring wheat breeding project has had about 600 yield plots ranging from standard variety trials for testing the most advanced experimental wheats against the currently available cultivars to 2nd & 3rd year yield trials of about 180 experimental lines per year to determine which lines to pursue for variety release. This work is funded by grants from the Minnesota Wheat Research & Promotion Council, US Wheat & Barley Scab Initiative via USDA-ARS, and the Small Grains Initiative. The Magnusson Research Farm has also been the site of spring wheat genetic studies to investigate the effects of different nitrogen rates on a protein-enhancing gene and a mapping population segregating for different vernalization genes. Soybeans are another breeding program that relies on the Magnusson Research Farm. It is an important testing location for the most northerly-adapted soybean varieties for variety testing as well as for advanced line testing for regional trials. All of the soybean grants involving

plant breeding projects involve testing at this location. The Magnusson Research Farm is also home to the Minnesota Canola Production Center, a long running canola research program partially funded by the USDA-NIFA through North Dakota State University and the North Central Region Canola Research Program. When Dr. Paul Porter decided to change his focus from research to teaching approximately ten years ago, the Magnusson Research Farm staff under the direction of Dr. Nancy Ehlke conducted the Canola Production Center research activities.

However, the major focus of the Magnusson Research Farm is to address producer problems associated with the turf and forage seed production systems in northwestern Minnesota. The research farm plays a critical role in the turf, forage, and cover crop breeding projects at the University of Minnesota. Our goal as researchers is to deliver new technologies through variety development activities, the introduction of new species and crops into production, and the development of better agronomic practices to support producers in the region. The land occupied by the Magnusson Research Farm was donated to the University of Minnesota in 1998 with the donor intent being to conduct research focused on grass and legume seed production, a unique agricultural production system. There is a long-standing relationship between the seed producers and the University of Minnesota dating back to the late 1940's. Prior to the acquisition of a permanent University of Minnesota research facility, the local seed grower groups provided the funding to rent a research site in the Roseau area. The growers now, primarily through the Minnesota Turf Seed Council, continue to provide financial and in-kind support to the numerous research programs and have funded a graduate student fellowship through the Foundation. The strong relationship between the growers and the University of Minnesota researchers provides an excellent educational opportunity for graduate students and post-doctoral fellows to experience a unique collaboration that has over a 70-year history and continues to be highly valued today.

The location of the Magnusson Research Farm is critical to meeting the research objectives of the grass and legume breeding projects at the University of Minnesota. Seed production of forage and turf species is highly environmentally sensitive and must be conducted in the specific production ecoregion. Grass seed produced in Minnesota has several advantages over seed produced in the Pacific Northwest. The seed is consistently of high quality and the seed is free of annual bluegrass seed, a noxious weed in the turf and sod industry. In northern Minnesota, perennial field crops such as Kentucky bluegrass and perennial ryegrass are desirable because they protect the soil from wind and water erosion by maintaining cover on the soil and by limiting tillage operations. In addition, grass and legume seed production fits well into the rotations used in northern Minnesota and distributes the work load across the growing season. The fields provide habitat for wildlife and grass seed production promotes diversity in agricultural practices. It was working in these cropping systems in northern Minnesota with their emphasis on perennial seed production that lead Dr. Donald Wyse to develop the framework for the Forever Green Initiative. Growers in the area continue to be on the forefront of the adoption of the Forever Green crops including the first commercial production of Kernza® seed in Minnesota.

One of the biggest success stories is the introduction of perennial ryegrass for seed production in northern Minnesota. Efforts continue to produce new varieties of turf-type perennial

ryegrasses with increased winter hardiness, improved turf quality, and herbicide tolerance. To date, we have released six cultivars of perennial ryegrass (Ragnar, Ragnar II, PolarGreen, ArcticGreen, Royal Green and Green Emperor) which were licensed to R-L Growers, a grower cooperative with members primarily from Roseau and Lake of the Woods counties. These licensed varieties have generated close to \$2 million dollars to the University of Minnesota. One of the major technologies we delivered to the grass seed growers was the development of herbicide tolerant perennial ryegrass cultivars. In the mid 1980's, Dr. Donald Wyse observed that classes of post-emergent grass herbicides (inhibitors of acetyl coenzyme A carboxylase, ACCase) did not injure fine fescues in seed production. This led to a large research effort by Wyse and others focused on understanding the mechanism of herbicide tolerance in the fine fescues and demonstrated these grasses carried an altered, less sensitive ACCase enzyme protecting the grasses from herbicide injury. This was followed by the discovery of a naturally occurring herbicide tolerant biotype of Italian ryegrass in Oregon. Our research effort shifted to focus on these ACCase tolerant grasses and we were able to demonstrate the herbicide tolerance in Italian ryegrass was also due to an altered, insensitive ACCase enzyme and was simply inherited as a partially dominant, single gene trait. This research culminated in the introduction of the herbicide tolerant trait from Italian ryegrass into perennial ryegrass which provided growers with technology for the first time to control quackgrass, a noxious weed, in their perennial ryegrass seed production fields and allow for a huge expansion in perennial ryegrass seed production acreage.

As we continue our breeding efforts to improve turf quality, winter hardiness, herbicide tolerance, disease resistance, it is imperative to test our experimental cultivars in the target production area to insure they have sufficiently high levels of winter hardiness and seed production potential. Perennial ryegrass seed production acreage has jumped from approximately 800 acres in 2001 to approximately 60,000 acres in 2020, which is the result from research conducted by the University of Minnesota. Because of the crop was recently being introduced in the area, there continue to be numerous research questions related to the production of perennial ryegrass such as fertility, disease management, weed control and growth regulator application. In addition, there continue to be producers new to seed production starting to produce perennial ryegrass seed. This has resulted in an increase in participation in the annual Grass Seed Institute meeting held in February and increased attendance at our summer field day tour of the Magnusson Research Farm. The grass seed producers continue to recognize and appreciate the value the research provided by the University of Minnesota researchers and are ardent supporters of the University of Minnesota. The Minnesota Turf Seed Council, the grass seed grower group, provides both financial and in-kind support to the University of Minnesota which helps fund graduate students, technical support, and the research programs.

Graduate students:

Graduate student	Degree	Dates	Thesis research	Advisor(s)
Margaret Mangan Wagner	M.S.	2005-2009	Native polycultures for bioenergy	Wyse and Sheaffer
Betsy Kurcinka	M.S.	2006 – 2009	Nitrogen fertility for turf seed production	Ehlke and Wyse
Claire Flavin Hodge	M.S.	2013 - 2016	Hairy vetch evaluations	Ehlke and Sheaffer
Garett Heineck	M.S. and Ph.D.	2014 - 2019	Perennial ryegrass breeding and seed production	Watkins and Ehlke
Mathew Ott	M.S.	2015 - 2018	Camelina and pennycress production	Wyse and Forcella
Garrett Heidenreich	M.S. degree terminated	2016 - 2018	Perennial ryegrass forage breeding	Ehlke and Sheaffer
Nicholas Wiering	M.S. and Ph.D.	2015 - present	Hairy vetch and perennial ryegrass breeding	Ehlke and Sheaffer
Charles Frahm	M.S.	2015 - 2018	Kernza® agronomics and seed production	Sheaffer and Jungers
David Herrera	M.S.	2017 – 2020	Fine fescue seed production	Ehlke and Watkins
Joan Barreto Ortiz	M.S.	2019 – present	Perennial ryegrass breeding and seed production	Watkins and Ehlke

Grants:

PI Name(s)	Agency	Amount	Dates	Title	Grad Student Training	Postdoc training
Current:						
Ehlke	Minnesota Turf Seed Council	\$128,000	7/1/15 – 6/30/17	Native and Turf Seed Production	Yes	No
Ehlke	USDA-NIFA (NDSU)	\$31,220*	9/1/15 – 8/31/16	Minnesota Canola Center	No	No
Watkins and Ehlke	MDA	\$240,217	7/1/16 – 6/30/19	Fine fescue: A new grass seed crop for Minnesota	Yes	Yes
Sheaffer, Ehlke and Wyse	MDA via Minnesota Turf Seed Council	\$150,000	7/1/14 – 6/30/17	Intermediate Wheatgrass: Managing a new perennial grain crop	Yes	Yes
Ehlke and Sheaffer	MDA	\$191,768	2/20/15 – 6/30/18	Developing new hairy vetch cultivars for winter cover	Yes	No
Ehlke	USDA-NIFA (NSDU)	\$45,420*	9/1/16 – 8/31/17	Minnesota Canola Center	No	No
Ehlke, Sheaffer and Martinson	MDA	\$201,439	4/11/16 – 6/30/19	New winterhardy perennial ryegrass to improve the profitability of grazing	Yes	No
Ehlke	MDA via Minnesota Canola Council	\$79,095	5/1/17 – 6/22/20	Reducing canola input costs through singulation and row spacing	No	No
Ehlke	Minnesota Turf Seed Council	\$147,000	7/1/17 – 6/30/19	Native and Turf Seed Production	Yes	No
Ehlke	USDA-NIFA (NSDU)	\$61,045	9/1/17 – 8/31/18	Minnesota Canola Center	No	No

Watkins, Ehlke, Hegeman	MDA	\$111,674	4/3/18 – 6/30/21	Increasing yields in perennial ryegrass seed production systems through agronomics and breeding	Yes	Yes
Watkins, Wells, Ehlke	MDA	\$249,998	4/1/19 – 6/30/22	Novel cropping systems for economic and environmental improvement in hard fescue seed production	Yes	Yes
Ehlke	USDA-NIFA (NSDU)	\$8,574*	9/1/18 – 8/31/19	Minnesota Canola Center	No	No
Ehlke	NIFA-OREI	\$165,542*	10/1/18 – 9/30/21	Selection to Distribution: Delivering regionally adapted cover crop varieties to organic farmers	Yes	No
Ehlke	MDA	\$108,090	4/1/19 – 3/30/22	Management practices to improve seed yield and stability of tall fescue	No	No
Ehlke	Minnesota Turf Seed Council	\$110,000	12/1/19 – 6/30/21	Native and Turf Seed Production	Yes	No
New:						
Ehlke, Jungers, Watkins	MDA	\$98,624	7/1/20 – 6/30/23	Residue Management in Kernza® and MNHD Hard Fescue Seed Production	No	No
Watkins, Ehlke	MDA	\$133,862.	7/1/20 – 6/30/23	Increasing multi-year seed production of fine fescue through plant breeding and agronomics.	Yes	No

*includes indirect costs

Supplemental Materials

Research plot numbers and descriptions in the Roseau, MN area from 2021

Progress Report on Grass Seed Production Research 2021

Small and Large Plot Research Projects Conducted at U of MN Magnusson Research Farm in 2021

<u>Variety Trials</u>	<u>Number of Plots</u>	<u>Research Lead</u>
Barley	128	Smith
Bluegrass	40	Ehlke
Canola	84	Ehlke
Canola shatter	52	Ehlke
Winter canola seeded fall 2021	48	Ehlke
Faba bean	9	Ehlke
Fine fescue	28	Ehlke/Watkins
Kernza 2017	48	Jungers
Kernza 2020	40	Jungers
Oats	96	Smith
Peas	21	Ehlke
Perennial ryegrass	56	Ehlke
Soybean	120	Lorenz
Spring wheat	873	Anderson
Tall fescue	48	Ehlke
Winter wheat - fall 2020	128	Wiersma
Hybrid Rye - fall 2020	256	Wiersma
Triticale - fall 2020	128	Wiersma
Total VT	2,203	
<u>Fertility</u>		
Canola fertility (NUE)	52	Ehlke
Canola wide row fertility	16	Ehlke
Canola micros	28	Ehlke
Fine fescue - fall vs spring nitrogen	12	Ehlke/Watkins
P&K wheat	64	Ehlke
P&K soybean	64	Ehlke
Large plot P&K	32	Ehlke
Perennial ryegrass - rate & timing	32	Ehlke
Hybrid Rye micros	24	Ehlke
Hybrid Rye - Magnusson	28	Ehlke
Hybrid Rye - Nitrogen Magnusson	24	Ehlke
Hybrid Rye - Nitrogen MF	24	Ehlke
Hybrid Rye, Winter wheat, Rye	60	Ehlke
MNHD fall nitrogen	20	Ehlke
Tall Fescue MF	32	Ehlke
Total Fertility	512	

Fungicides

P ryegrass - Mag Farm	24	Ehlke
Tall Fescue - MF	12	Ehlke
<u>Total Fungicides</u>	36	

Biomass and Integrated Plant Species Research

Kernza residue management	16	Ehlke
MNHD residue management	16	Ehlke
Tall Fescue residue management	16	Ehlke
Polyculture biomass	72	Wyse
Fine fescue establishment -Florence	48	Ehlke/Watkins
P ryegrass spring clip trial Rice & MF	32	Ehlke
Volunteer wheat regrowth	6	Ehlke
MNHD Establishment	6+16	Ehlke
Tall fescue establishment timing - MF	20	Ehlke
Tall fescue residue management Tveit	32	Ehlke
<u>Total Biomass</u>	280	

Herbicides

Canola Pre herbicides	16	Ehlke
Fine fescue herbicide screen	21	Ehlke/Watkins
MNHD herbicide screen	15	Ehlke/Watkins
P ryegrass spring herbicide screen	44	Ehlke
Hybrid Rye- Magnusson	24	Ehlke
Avadex in ryegrass - Rice	24	Ehlke
Callisto in Ryegrass & Tall fescue	24	Ehlke
<u>Total Herbicides</u>	168	

Growth Regulators

Tall fescue	12	Ehlke
Ryegrass - Rice	44	Ehlke
<u>Total Growth Regulators</u>	56	Ehlke

Other Trials

Armyworm survey(# of sampling dates)	28	Ehlke
Canola flea beetle	44+44	Ehlke
Ryegrass crossing block	49	Ehlke
P ryegrass winter hardiness	56+56	Ehlke
Joan's ryegrass project	320	Ehlke
Swath wheat stubble height w/ryegra	9	Ehlke
Ryegrass desiccation for direct harvest	12	Ehlke
<u>Total Other Trials</u>	618	

Grand Total for 2021 **3,873**

PROGRESS REPORT ON GRASS SEED PRODUCTION RESEARCH

prepared by

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Grass-Legume Seed Institute Presentation

Roseau, MN - February 24, 2022

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

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

Table 1. Precipitation/Weather Data 1967-2021.

Variety Performance Trials:

Table 2. Perennial Ryegrass Seeded in 2020.

Table 3. Fine Fescue Seeded in 2019.

Table 4. Tall Fescue Seeded in 2018.

Table 5. Perennial Ryegrass Winter Hardiness Trials Seeded in 2020.

Table 6. Intermediate Wheatgrass Seeded in 2017.

Table 7. Intermediate Wheatgrass Seeded in 2020.

Table 8. Field Pea-Faba Bean Variety Trial Seeded in 2021.

Perennial Ryegrass Management Trials:

Table 9. Fertility Trial-MagPlots.

Table 10. Annual Summary of Fertility Trials-MagPlots.

Table 11. Herbicide Management Trial-MagPlots.

Table 12. Growth Regulator Applications-Rice Farms.

Table 13. Wolverine and Growth Regulator Mixes-Rice Farms.

Table 14. Gramoxone and Roundup Pre-Harvest Effects on Germination.

Table 15. Fungicide Application Trial-MagPlots.

Table 16. Avadex Applications for Wild Oat Control-Rice Farms

Table 17. Combine Height on Wheat with Underseeded Ryegrass-Magnusson Farm

Table 18. Spring Straw Management on Ryegrass-Rice Farms and MagPlots.

Table 18a. Straw Management Summary-Rice Farms/MagPlots.

Table 19. Volunteer Wheat Regrowth Forage Yield-MagPlots.

Other Trials:

Table 20. Kernza Residue Management-MagPlots.

Table 21. Hard Fescue Fertility-MagPlots.

Table 22. Hard Fescue Residue Management-MagPlots.

Table 23. Hard Fescue Fall Herbicide Screen-MagPlots.

Table 24. Hard Fescue Establishment-3 Locations.

Table 25. Tall Fescue Residue+Fertility Management-Ravndahlen Farms.

Table 26. Tall Fescue Nitrogen Fertility Trial-MagPlots

Table 27. Tall Fescue Establishment-MagPlots.

Table 28. Tall Fescue Growth Regulator Applications-MagPlots.

Table 29. Tall Fescue Fungicide Trial-MagPlots.

Table 30. Per.Ryegrass and Tall Fescue Callisto Applications-MagPlots.

Table 31. Soybean and Wheat Large Plot Fertility Trial - Braaten/West Plant/Slater.

Table 32. Wheat and Soybean P & K Fertility Rotation Trial Summary - MagPlots.

Table 33a-c. Rye Micronutrient, Nitrogen and Herbicide Trials-Magnusson Farm.

Table 34a-b. Rye and Winter Wheat P & K Fertility-MagPlots.

Table 35. Army Worm Moth Capture Survey by Location and Date.

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.

2021 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
Ravndahlen/Tveit farms= 3 miles south of Arnesons Rocky Point

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°) 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	7.35	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	1.73	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	2.70	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	-4.26	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	-3.48	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	-1.16	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	3.89	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	-4.53	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	-6.75	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	-3.14	37.7
1978	0.36	0.26	0.17	1.00	1.97	1.92	6.25	3.25	3.44	0.23	0.98	0.79	20.62	-1.96	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	-5.12	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	-3.43	36.0
1981	0.27	0.16	0.66	0.56	2.79	6.85	2.63	2.41	3.63	1.75	0.90	0.99	23.60	1.02	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	-2.37	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	-0.63	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	-5.15	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	2.47	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	-3.20	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	-4.66	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	-5.65	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	-0.87	M
1990	0.55	0.20	1.12	1.09	0.46	3.19	2.48	0.62	0.91	0.16	0.18	0.72	11.68	-10.90	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	7.71	M
1992	0.61	0.68	0.45	2.27	1.99	2.36	2.72	4.51	2.76	0.12	1.27	0.88	20.62	-1.96	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	-0.79	35.5
1994	0.21	0.33	0.47	0.02	0.16	2.54	3.03	3.48	3.94	1.38	2.72	0.32	18.60	-3.98	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	-0.63	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	3.41	M
1997	1.06	0.14	1.02	0.84	2.02	3.36	4.02	1.31	4.01	2.45	0.19	0.25	20.67	-1.91	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	2.36	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	0.31	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	5.65	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	-3.79	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	3.24	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	1.89	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	11.55	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	8.71	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	-6.09	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	2.72	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	3.94	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	3.98	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	5.33	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	-4.86	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	-3.48	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	1.49	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	3.16	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	8.57	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	1.49	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	0.58	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	-4.43	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	9.49	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	2.92	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	-4.92	42.1

52 year average annual precipitation 22.58

50 year available mean temperature= 37.3

*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=24.68". Average precipitation the previous 33 years=21.16"

Table 2.

2020 Perennial Ryegrass Seed Production Variety Trial
Magnusson Research Farm-Roseau,Mn. 2021 data and yields 2019-21

Company	Variety	Seed Lot#	Seed Yield(#/acre)				Seed Yield as % of Mean			Harvest Ht.(in.)	Date	Heading (%)					
			2021	2020	2019 ¹	3yr.ave	2021	2020	2019 ¹			6/3	6/7	6/10	6/13	6/17	6/21
U of M	Green EmperorxRoyal Green	4020	1571	1384	1240	1398	129	108	124	18	14-Jul	4	10	38	70	90	98
U of M	Arctic Green	4113	1324	1364	1347	1345	109	107	134	18	17-Jul	0	5	20	50	73	94
DLF	Dilligent	4127	1315	NA	NA	NA	108	NA	NA	17	17-Jul	2	9	20	45	80	95
Pure Seed Testing	Gray Fox	4129	1277	1259	977	1171	105	99	98	18	17-Jul	4	13	30	58	76	95
U of M	Galactic Green(3999)	4050	1255	1286	1262	1268	103	101	126	18	19-Jul	1	6	30	50	73	91
Mountain view seed	Superstar GL	4125	1242	1420	1145	1269	102	111	114	17	19-Jul	1	6	25	45	78	95
U of M	Spreader IIIxArctic Green	4051	1199	1386	1233	1273	99	109	123	17	14-Jul	3	9	28	53	76	94
check	NK-200	3917	1179	1130	810	1040	97	88	81	24	23-Jul	0	6	15	43	70	93
U of M	Green Emperor	3976	1173	1426	1060	1220	97	112	106	15	19-Jul	1	7	23	45	70	93
Pure Seed Testing	Silver Sun	4128	1155	1130	907	1064	95	88	91	17	13-Jul	10	30	48	80	92	98
Pure Seed Testing	Silver Sport	4130	1113	1310	1130	1184	92	103	113	15	15-Jul	5	18	43	68	88	97
U of M	EPR-18(early line)	4103	1090	1264	NA	NA	90	99	NA	19	21-Jul	0	2	8	20	45	83
Mountain view seed	Sliders LS	4126	1084	NA	NA	NA	89	NA	NA	17	19-Jul	2	8	19	45	73	91
U of M	Forage-2018	4100	1030	1017	731	926	85	80	73	18	20-Jul	0	3	18	40	73	94
LSD @5% level			179	135	105	108	15	10	10	2	3	3	6	15	15	14	6
CV(%)			10	7	7	7	10	7	7	6	14	81	45	40	21	13	4
Trial mean by year			1215	1277	1003												

Experimental design:RCB with 4 reps

Planted 5/5/2020 with Linkert spring wheat @7#/acre

¹- NA - Variety not planted and information not available

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Table 3.

2019 Fine Fescue Seed Production Variety Trial
Magnusson Research Farm-Roseau,Mn. 2021 data and yields from 2020.

Species	Variety	Seed Lot#	Seed Yield(#/acre)			Harvest Ht.(in.)	Lodging ¹	Harvest Date	Heading (%)						
			2021	2020	2yr.ave				5/18	5/21	5/24	5/29	6/3	6/7	6/10
hard fescue	MN-HD	4065	1128	906	1017	21	1.0	26-Jun	9	28	55	78	94	99	99
hard fescue	SPHD	2	1006	765	886	20	1.0	29-Jun	6	20	58	78	95	99	99
hard fescue	Beacon	3	690	699	694	21	1.8	28-Jun	1	13	43	63	89	95	99
hard fescue	Gladiator	4	467	579	523	21	1.5	29-Jun	1	6	28	50	79	90	99
hard fescue	Jetty	5	959	681	820	21	2.3	28-Jun	5	15	40	60	91	99	99
chewing	Radar	6	788	661	724	25	2.5	1-Jul	0	0	1	18	53	83	96
strong creeping	Chantilly	7	58	402	230	20	1.0	1-Jul	0	0	0	1	4	8	10
LSD @ 5% level			209	102	117	2	0.7	2	4	9	9	8	10	7	2
CV(%)			19	10	11	30	5	4	86	55	20	11	10	6	2
Trial mean by year			728	670											

Experimental design:RCB with 4 reps

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

¹-Lodging; 1=upright; 9=flat

Table 4.

2018 Tall Fescue Variety Trial
Magnusson Research Farm-Roseau,Mn

Variety	MSP#	Source	Seed Yield(#/acre)				Harvest Ht.(in.)	Heading (%)			
			2019	2020	2021	2019-21		6/7	6/10	6/13	6/17
Cumberland	4080	Pure seed testing	1393	1346	725	1155	26	2	18	40	74
Rodin	4079	Integrated Seed Growers	1382	1496	690	1189	30	1	25	48	80
Titanium	4095	Mountain View Seed	1351	1555	790	1232	27	1	13	35	63
MN-TF15	4074	U of Mn-Watkins	1311	1697	599	1202	26	0	11	30	66
Monet	4077	Integrated Seed Growers	1210	1467	772	1150	31	2	30	55	84
Essential	4082	DLF	1144	1184	441	923	25	1	10	30	58
Davinci	4076	Integrated Seed Growers	1099	1206	779	1028	35	1	30	58	83
Raindance	4081	Pure seed testing	1084	954	583	874	28	1	18	43	75
Rembrandt	4078	Integrated Seed Growers	1075	1184	452	903	30	1	13	30	61
Coronado	4093	Pure seed testing	1006	1042	514	854	32	4	33	60	84
Bloodhound	4083	DLF	990	1094	423	836	28	1	13	33	64
K-31	4075	Integrated Seed Growers	761	952	432	715	37	11	43	68	90
LSD @5% level			216	279	115	148	3	3	7	9	10
CV(%)			13	15	13	10	7	105	25	15	9

Experimental design:RCB with 4 reps

All harvested 7-16-21 Trial Mean #/acre= 1151 1265 600

2021 Data + 2019&2020 Seed Yields

Added fertilizer= 140-40-40-10s split fall/spring

Residue baled after harvested + clipped and baled 9/15/2020

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Table 5.

2020 Perennial Ryegrass Winter Hardiness Trial
Magnusson Research Farm Roseau,Mn & U of Minn. St. Paul Campus

Variety	Seed lot	Winter Injury ¹		
		Roseau 5/8/21	St.Paul 4/7/21	Mean
Green EmperorxArctic Green	4031	2.5	1.0	1.8
Green Emperor	3976	2.0	1.0	1.5
Annual	4134	9.0	1.5	5.3
Galactic Green (3999)	4050	2.0	1.0	1.5
NK-200	3917	3.0	1.0	2.0
Accent II	4096	2.3	1.0	1.6
Forageur	4043	2.0	1.0	1.5
Arctic Green	4038	2.3	1.0	1.6
Spreader IIIxArctic Green	4051	4.0	1.0	2.5
Forage sel-2019	4150	2.3	1.0	1.6
Silver Sport	4130	1.0	1.0	1.0
EPR-18	4103	2.8	1.0	1.9
Forage sel-2020R	4148R	3.3	1.0	2.1
Forage sel-2020S	4149S	3.3	1.0	2.1
LSD @5% level		1.0	0.2	0.5
CV(%)		25	14	19

Experimental design:RCB with 4 reps

Single row plots planted-

Roseau = 9/9/2020

St.Paul =9/14/2020

¹-Winter injury(visual rating)- 1= no injury; 9=dead.

Table 8.

2021 Field Pea Variety Trial
Magnusson Research Farm. 2021 data and 2019-2021 yield

Field Pea

	Bu/acre ¹			Harvest ht(in)	Flower Date	
	2021	2020	2019		1st	last
5 ACC Chrome	58.5	NA	NA	21.7	23-Jun	10-Jul
3 Shamrock	50.6	NA	NA	23.0	24-Jun	10-Jul
2 Empire	45.2	NA	NA	29.0	24-Jun	11-Jul
1 Cronos	43.4	17.7	NA	22.7	17-Jun	8-Jul
6 AAC Profit	48.5	36.2	108	25.0	24-Jun	11-Jul
4 Spider	46.2	24.5	96	24.3	24-Jun	10-Jul
7 Salamanica	49.8	36.6	96	24.0	22-Jun	9-Jul
LSD @ 5% Level	14.1	14	11	2.8	1	1
LSD @ 10% Level	11.6	.	.	3.4	1	1
CV(%)	16	34	7	8	2	6

Experimental Design: RCB w/3 reps

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2021 Faba Bean Variety Trial
Magnusson Research Farm. 2021 data and 2019&2021 yield

	Bu/acre ¹		Height(in)
	2021	2019	Harvest
Boxer	29.3	68	29
Victus	30.0	NA	28
EXP14	27.3	NA	26
LSD @ 5% Level	2.0	NS	2
LSD @ 10% Level	1.5	NS	2
CV(%)	3	11	4

Experimental Design: RCB w/3 reps

Blister beetle most active on Boxer and Victus in 2021

Plots not harvested in 2020 due to flooding.

Management of both trials all years-

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

Herbicide application-

Authority Elite 1.5pt.acre applied immediately after planting .

Site= Conventional tillage seedbed- Non-irrigated

Fertility application 10-50-50 Soil type- sandy loam

Previous crop- spring wheat

Planting Date= 5/7/2021(as early as possible in spring)

Harvest date-Faba beans 9/13/2021; Field Peas- 8/18/2021

Faba bean Seeding Rate= 197,000PLS/acre

Field pea Seeding Rate= 350,000PLS/acre

Table 9.

2020-21 Perennial Ryegrass Fertility Trial
Magnusson Research Farm-Roseau,Mn

TRT#	Total N level	Application ¹ timing	Seed Yield ²		Harvest Ht(in.)	RCI ³		
			#/acre	% mean		5/24	6/9	7/26 ⁴
1	0-0-0	0	331	26	12	139	195	93
2	140+0+0	30-0-0--10/20	1324	104	18	449	537	121
3	140+0+0	30-0-0--10/20--0-40-0 4/27	1264	99	17	436	508	120
4	140+0+0	No fall N	1353	106	18	345	528	141
5	100+0+0	30-0-0--10/20	1168	92	17	386	453	106
6	140+0+0+20s	30-0-0-20s--10/20	1331	104	16	465	558	118
7	140+0+0+70s	30-0-0-20s--10/20	1351	106	17	392	509	102
8	100+0+0	30-0-0- same trt#5	1144	90	16	388	492	99
LSD @5% level			155	12	2	52	57	20
CV(%)			9	9	8	9	8	12

Experimental Design:RCB w/4reps

Variety=Arctic Green

Perennial ryegrass spring seeded 5/2020 under wheat.

Mean yield(not including 0# N)= 1276#/ac

Trt#	Season	Treatment applications and timing ¹	Total #N	Treatment Explanation-*
1	17	No added N fertilizer		No added N
2	140	30-0-0 on 10/13+95 -0-0 on 4/27		30#N oct- STANDARD- BMP
3	140	30-0-0 on 10/13+95-40-0 on 4/27		Standard + 0-40-0 spring
4	140	none in fall+125-0-0 spring		spring only N
5	100	30-0-0 on 10/13+55-40-0 on 4/27		30#N Oct-low N
6	140	30-0-0-20s on 10/13+95 -0-0 on 4/27		30#N oct + 20# sulfur Oct(82#AMS)
7	140	30-0-0-70s on 10/13+95 -0-0 on 4/27		30#N oct+20# sulfur oct(82#ams)+50#sulfur Spring(208#AMS)
8	100	30-0-0 on 10/13+55-40-0 on 4/27		30#N Oct-low N(40# liquid N was not applied)same trt# 5

All plots received 17-40-40-10s 9-11-2020

*-Standard application= 30#N on 10/13/2020
and remaining 110#N on 4/27/2021.

10/11/2020 Soil test results

Depth	Olsen P	K	% OM	PH	NO3-N
0-6"	8 ppm	125 ppm	2.7	8.3	9 ppm
6-24"					7 ppm

* Rational for treatments

¹Treatment application not including 17-40-40-10s on 9/11/2020.²Seed Yield - Clean seed yield of each treatment in LBS/Acre and % of trial mean (not including no added N trt#1)³RCI-Relative Chlorophyll Index-higher value=more chlorophyll⁴RCI scored in harvested area. May be an indication of residual nitrogen after harvest

Table 10.

2011-21 Perennial Ryegrass Fertility Trial Seed Yield Summaries
Magnusson Research Farm-Roseau,Mn

Trt. #	Nitrogen Fertilizer	Nitrogen Timing	Overall ³ Mean	2021	Seed Yield as % of Mean									
					2020	2019	2018	2017	2016	2015	2014	2013	2012	2011
1	0	0	29	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	104	104	111	101	99	110	99	104	104	118	118
4	140+40+0	Split ¹ +(0-40-0spring)	108	99	96	100	107	106	109	127	120	----	----	----
5	140+0+0+20s	Split ²	101	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				12	10	13	11	13	12	20	11	16	11	12
CV(%)				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)-- 1276 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 May³-Treatment 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

Observations/Conclusions- from past fertility trials

Applying 10-20% of spring nitrogen as ESN has been beneficial in some years and is applied to perennial ryegrass at the U of M research farm as BMP.

Treatment #4 (ie. Adding 0-40-0 in spring) is less beneficial if beneficial at all, if P2O5 soil test levels above 7ppm

table 11.

**2021 Perennial Ryegrass Herbicide Management Trial
Magnusson Research Farm**

Trt#	Herbicide Treatment	Rate	Manage Level ¹	Seed Yield(#/acre)			Yield as % of mean	Ht(in.) Harvest	Color ³ 7/10	RCI ⁴ 7/10	% Germ ⁵
				2021	2020	2yr.ave					
1	Quelex+Widematch+.25%NIS/Tacoma	.75oz+1pt/10oz	BMP	1297	1370	1334	100	16	5.3	212	89
2	Callisto+Sterling Blue+2,4-D/Tacoma	3oz+12oz+12oz/10oz	BMP	1388	1546	1467	110	16	4.5	218	
3	Callisto+Sterling Blue+2,4-D/Tacoma	6oz+12oz+12oz/10oz	BMP	1206	NA ²	NA	NA	16	5.3	214	93
4	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP -	1235	1506	1371	102	17	4.3	177	
5	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP	1374	1412	1393	104	16	5.3	217	90
6	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP +	1224	1541	1383	103	16	5.0	184	
7	Sterling Blue+2,4-D/Tacoma	12oz+12oz/10oz	BMP ++	1197	1356	1277	95	17	4.5	197	
8	Wolverine	1.7pt +1pt.	BMP	1304	1359	1332	100	15	5.0	185	93
9	Facet+2,4-D+Sterling Blue	1.5pt+12oz+12oz	BMP	1257	1362	1310	98	15	4.8	192	92
10	Sterling Blue+2,4-D+Dual II/Tacoma	12oz+12oz+1pt/10oz	BMP	1311	1394	1353*	101	15	5.8	186	
11	No Treatment		BMP	1108	1263	1186	88	15	5.3	193	90
LSD @ 5% Level				148	138	137	10	1	1.3	29	
CV(%)				8	5	5	5	4	18.0	10	

Experimental design:RCB with 4 reps

Mean Yield-

1264

1411

1338

Harvest date=7-21-21

Variety=Arctic Green-- 3/4pt 2.4-D+3/4pt.Banvel applied 9-15-2020 to all plots

*Prowl H2O in 2020 and Dual II Magnum in 2021

¹Management level- Other than herbicide application²6 oz. Callisto treatment 2021 only³Color=visual rating 9= dark green; 1= light green⁴RCI=Relative chlorophyll index- higher number=higher relative amount of chlorophyll⁵%Germination- Germinations of harvested seed of selected treatments.

5/27/2021 45f 1

6-2-21 9am 67F ssw4 54%RH

6-9-21-ESE 6-10 10%hd ht 12" 75F

6-25-21 Fungicide applications= 9:30am wsw 2-6mph 70F RH 80%

mid pollen shedding- fully headed 15" growth ht.

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--	Quelex+WideMatch 5-24 / Tacoma 6-2/ Apogee + Tilt+ 2 gal 28%N 6-9 / Priaxor +1 gal 28%N 6-25
2--	3oz Callisto+ 2,4-D+ Sterling Blue 5-24/ Tacoma 6-2/ Apogee + Tilt+ 2 gal 28%N 6-9 / Priaxor +1 gal 28%N 6-25
3--	6 oz Callisto+ 2,4-D+ Sterling Blue 5-24/ Tacoma 6-2/ Apogee + Tilt+ 2 gal 28%N 6-9 / Priaxor +1 gal 28%N 6-25
4--	2,4-D+ Sterling Blue 5-24/ Tacoma 6-2/ Apogee + 2gal 28%N 6-9 / Folicur 6-25
5--	2,4-D+ Sterling Blue 5-24/ Tacoma 6-2/ Apogee + Tilt+ 2gal 28%N 6-9 / Priaxor 6-25+1gal 28%N 6-25(standard BMP)
6--	2,4-D+ Sterling Blue 5-24/ Tacoma + 2gal 28%N +Folicur 6-12/ Apogee + Quilt+ Warrior+2gal 28%N 6-9 / Priaxor +1gal 28%N 6-25
7--	2,4-D+ Sterling Blue 5-24/ Tacoma + 2gal 28%N +Folicur 6-12/ Apogee + Quilt+ Warrior +2gal 28%N 6-9 / Priaxor +Warrior+1gal 28%N 6-25
8--	2,4-D+ Sterling Blue 5-24/ Tacoma +2 gal 28%N +Folicur 6-12/ Apogee + Quilt +2gal 28%N 6-15 / Priaxor+1gal 28%N 6-25
9--	Wolverine 6-12/ Apogee + Tilt + 2gal 28%N 6-15 / Priaxor + 1gal 28%N 6-25
10--	2,4-D+ Sterling Blue+Dual II Magnum 5-24/ Tacoma 6-2/ Apogee + Tilt+ 2 gal 28%N 6-9 / Priaxor +1 gal 28%N 6-25
11--	NO HERBICIDE--Apogee + Tilt+ 2 gal 28%N 6-15 / Priaxor +1 gal 28%N 6-25

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
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
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#LAMBDAHALOTHIRIN	1.5oz
Folicur	3.6#Tebuconazole	4oz

Table 12.

**2021 Growth Regulator Applications to Perennial Ryegrass
Rice Farms- 6 miles NW of Roseau**

Treatment	Rate	Additive	Seed yield #/acre	Harvest Height
1 No treatment		None	981	18
2 Palisade EC	.75pt	.25%NIS	995	17
3 Palisade EC	1.5pt	.25%NIS	888	16
4 Apogee	4oz.	.25%NIS+3gal.UAN	906	15
5 Apogee	6oz	.25%NIS+3gal.UAN	952	15
6 Apogee	8oz.	.25%NIS+3gal UAN	961	14
7 Apogee	8oz.	.25%NIS+2.5% UAN	975	16
8 Apogee	8oz.	.25%NIS+3gal.AMS	1030	16
LSD @ 5% Level			NS	1
CV(%)			10	6

Experimental Design:RCB/w 4 reps Variety-Evolution

Wolverine 1.7pt./ac +1pt Amsol 6/8
PGR applied 6/9/2021 ESE 8-12mph 10% heading

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Table 13.

**2021 Wolverine and Growth Regulator Applications to Perennial Ryegrass
Rice Farms-Roseau,Mn**

trt	Treatment	Seed yield #/acre	Harvest Height
1	Wolverine/Apogee	1164	15
2	Wolverine+Apogee	1166	17
3	Wolverine+Palisade	1046	17
LSD @ 5% Level		NS	1
CV(%)		6	4

Experimental Design:RCB/w 4 reps Variety-Evolution

PGR all and combos 6/9/21 10"ht 76F ese5-8 20%heading

Wolverine alone applied - 6/2/2021 at 9am 67F ssw4 56%RH

trt	Treatment	Timing	Timing
1	Wolverine/Apogee	6/2 & 6/9	1.7pt. + 1pt AmSol(.5#AMS) / 6oz+.25%NIS+2.5%UAN
2	Wolverine+Apogee	9-Jun	1.7pt. + 6oz+.25%+2.5%UAN
3	Wolverine+Palisade EC	9-Jun	1.7pt.+ .75pt +.25%NIS

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Table 14.

**2021 Perennial Ryegrass Desiccation Treatments Applied as a Pre-harvest Aid
Magnusson Research Farm**

Treatments and Rates	%Germ ¹	Abnormal ²
1.5Pts. Gramoxone+.25%NIS	81	9
1.5Pts. Roundup PowerMax+1pt Amsol	90	2

3 strips applied of each treatment 7-25-2021 prior to harvest(Seed mature at application)

¹%Germination- Selected treatments that may influence seed germination of harvested seed.

²Abnormal germinations added to show possible effect of herbicide treatment

Table 15.

**2021 Fungicide Trial on Perennial Ryegrass
Magnusson Research Farm**

Treatment Name	Rate	Adjuvant	Seed yield #/acre	Height harvest	10-Jul Color ¹	10-Jul RCI ²
Untreated Check			1128	17	4.3	190
Tebuconazole	3oz	.25%NIS	1117	16	4.3	167
Badge SC	1pt		1115	17	5.5	190
Tebuconazole+Badge	3oz.+1pt	.25%NIS	1157	17	4.5	184
Quilt Xcel	12oz	.25%NIS	1159	16	4.3	188
Priaxor D	6oz	.25%NIS	1148	16	4.5	185
LSD @ 5% Level			NS	NS	0.8	NS
CV(%)			9	3	11	8

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

¹Color-visual rating 1=light green;10=dark green

²RCI-Relative Chlorophyll Index-higher number =higher relative amount of chlorophyll

Applied 6/25/2021 wind west 2-6mph 10:30am ryegrass 15" fully headed and heavy pollen shedding

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Table 16.

**2021 Avadex Applications to Perennial Ryegrass for Resistant Wild Oat Control
Rice Farms-6 mi. NW of Roseau**

Treatment	Application		Seed Yield #/acre	Height harvest	Injury ¹ harvest	Stunting ² 7-Jul	Vigor ³ 7-Jul	wild oat control ⁴	%Germ ⁵
	Timing	Rate							
Untreated Check	none		1101	16	1.0	2.7	6.0	0	90
Avadex MicroActiv	23-Apr	10#	929	14	2.7	4.7	5.3	55	
Avadex MicroActiv	23-Apr	15#	940	13	5.7	5.3	6.3	80	89
Avadex MicroActiv ⁶	23-Apr	10#+Till	899	13	5.7	6.3	6.7	75	85
Tacoma	1-Jun	10oz.	941	13	1.7	4.0	5.7	85	
Dual II Magnum	23-Apr	1 pt	1041	13	4.0	5.3	6.3	0	
Avadex/Tacoma	4/23+6/1	10#/10oz	819	14	3.3	6.0	6.3	70	88
Avadex+Dual II	4/23+4/23	10#/1pt	896	13	6.3	6.7	6.7	40	91
LSD @ 5% Level			203	2	1.8	1.2	NS	NA	
CV(%)			12	7	27	13	16	NA	

Experimental Design; RCB w/3reps(no appropriate location for rep 4)

¹Injury at harvest-9=most;1=none

²Stunting-9=worst;1=least

³Vigor- 9=most ; 1=best

⁴Wild oat control at harvest= %control-visual rating- insufficient data to run statistical analysis

⁵%Germination- Selected treatments that may influence seed germination of harvested seed.

⁶Spike tooth harrow used to incorporate Avadex after application in Trt# 4

Avadex and Tacoma applications made 4-28-21 11am,62F wind se5 39%RH hazy sun

Tacoma applied to trts. 5&7 6/9/2021 3pm wsw 10-15 80F 10% heading

3oz. Grizzly II applied to all plots 6/29/2021 ;all other operations were applied as BMP.

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

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 Lambda-cyhalothrin 1#

Warrior w Lambda-cyhalothrin 2.08#

Avadex MicroActiv Triallate 10%

Table 17.

**2021 Ryegrass Yields with Spring Wheat Combined at Various Heights in 2020
Magnusson Farm-1 mile west of Roseau**

Stubble Height	Seed Yield ¹ #/acre	RCI ² 8/3/2021
2"	1845	101
5"	1717	119
10"	1575	136

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

¹- Weigh wagon yields of perennial ryegrass from combine. Insufficient replication for statistical analysis

²-Relative Chlorophyll Index of perennial ryegrass- higher number=more chlorophyll

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Table 18.

**2021 Spring Residue Management - Perennial Ryegrass
2 Locations¹ -Roseau ,Mn**

Treatment	Seed yield-#/acre		Harvest Ht(in.)		6/9 RCI ²	
	Rice	MagPlot	Rice	MagPlot	Rice	MagPlot
1-no treatment	1172	972	17	15	493	442
2-Clip 3"	1222	1050	17	16	530	399
3-Clip 3"-Rake off straw	1380	975	17	15	536	438
4-Harrow	1243	NA	16	NA	507	NA
LSD @ 5% Level	118	NS	NS	NS	NS	NS
CV(%)	4	14	6	4	8	10

Experimental Design= RCB w 4 reps-MagPlot & 3 reps Rice Farms

¹-Locations-MagPlot-Magnusson research farm ---Rice Farms- 6 miles NW of Roseau,Mn

²-Relative Chlorophyll Index of perennial ryegrass- higher number=more chlorophyll

Varieties- Evolution Rice Farms & Arctic Green MagPlots

Treatments imposed 4/27/2021

Harvest date - 7-20-21--both locations

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Table 18a.

**Spring Residue Management Seed Yield Summaries-2018-2021
Rice Farms 2018 and 2021
Magnusson Research Farm-2019-20**

Trt#	Clip Treatment ¹	Seed Yield-#/acre				Mean
		2021	2020	2019	2018- ²	
1	No Treatment	1172	1395	1386	1430	1345
2	Clip only	1222	1475	1497	NA	1398
3	Clip-Rake off	1380	1537	1611	1610	1535
4	Harrow	1243	NA	NA	NA	NA
	LSD @ 5% Level	118	NS	197	63	
	CV(%)	5	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 late April-early May

Wheat stubble= 7". Clip height=3"

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

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Table 19.

**2021 Volunteer Wheat Regrowth with Underseeded Ryegrass
Magnusson Research Farm¹**

Volunteer Wheat Cut Height	Cut Date ¹ 10/25/2021	Crude ² Protein
3"	.63 Tons/ac.	30%
6"	.40 Tons/ac.	33%

Wheat stubble height - 5"

¹-Linkert spring wheat harvested 8-6-2021. Volunteer harvested and dry matter yield here.

Wheat regrowth cut at 2 heights,dried and reported here.

²-Crude protein levels are approximate based on growth stage and cut height.

Table 20.

**2020 Kernza Residue Management
Magnusson Research Farm**

TRT#	Treatment	Seed yield #/acre	Dry Matter tons/acre	Harvest (In.)
1	Burn	604	2.5	51
2	Bale at harvest	433	2.1	49
3	Bale-Short clip+Bale	392	1.8	47
4	No Treatment	264	1.4	47
	LSD @ 5% Level	205	0.7	NS
	CV(%)	30	25	8

Experimental Design:RCB/w 4 reps

Harvest Date= 8-9-2021 Kernza -MN-Clearwater

Harvested 8/5/2020

Trt#1 Burned 8-11-2020

Trt#2 Raked off 8-10-2020

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

Trt#4 Kernza harvested and residue left on plot

Table 21.

**2020-21 Hard Fescue Fertility Management
Magnusson Farm-1 Mile SW of Roseau,Mn**

Added Fertilizer	Seed	RCI ¹		Harvest
	Yield(#/ac)	5/18/21	Harvest	Ht(in.)
0-40-40	378	136	148	18
40-40-40	670	192	176	20
80-40-40	903	254	204	21
120-40-40	854	317	305	20
160-40-40	1001	363	324	22
LSD @ 5% Level	161	49	75	1
CV(%)	13	12	21	4

Experimental Design-RCB w 4 reps

Harvest Date-6-25-2021

Fertilizer applications -September 25,2020

¹Relative Chlorophyll Index- higher number=more chlorophyll

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Table 22.

**2020 MN-HD Hard Fescue Residue Management
Magnusson Farm-1 Mile SW of Roseau,Mn**

	Seed	Harvest
	Yield(#/ac)	Ht(in.)
1-Desiccate-Burn	601	20
2-Bale after harvest	567	21
3-Bale-Cut/Bale late	514	19
4-no treat	418	20
LSD @ 5% Level	138	2
CV(%)	16	5

Experimental Design-RCB w 4 reps

Trt#2-3- baled off after harvest 7-9-2020

Trt#3- clipped/raked off 9-15-20

Trt#1-Gramoxone Max applied 7/30/2020 4pm 81F 42%RH wind s 1-3mph south
and burned 8-6-2020 Harvested 6-25-2021

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Table 23.

**2020 Grass Herbicide Screen in Seeding Year on Hard Fescue
Magnusson Research Farm**

Treatment	Rate+adjuvant	Application	Seed Yield	Height(in)
		Date		
Section 3	6oz.+1%COC	7/29/2020	634	20
Fusilade DX	12oz+1%COC	7/29/2020	730	20
Section 3	6oz.+1%COC	9/15/2020	462	19
Fusilade DX	12oz+1%COC	9/15/2020	549	19
No Treatment			617	19
		LSD @ 5% Level	133	NS
		CV(%)	12	5

Experimental Design-RCB w 3 reps variety=MN-HD

Hard Fescue planted 5/10/2020 with no cover crop

Date 1 application- 7-29-2020 trt 1& 2 fescue g. height= 3/4"-1.5"
10am 64F 81%RH wind W2mph

Date 2 application- 9-12-2020 730pm fescue g. height =1-2.5" ht.
730 pm 66F 56rh wind 5 wnw

Harvest Date=6/30/2021

Table 24.

2019-2020 Hard Fescue Establishment Trial Summaries *
Roseau, St. Paul and Rosemount Locations

2020 MN-HD Hard Fescue Establishment with Nurse Crop
Roseau and Rosemount

Nurse crop	2021 Seed Yield(#/acre)	
	Rosemount	Roseau
alone	1201	976
spring wheat	799	648
flax	941	795

Nurse crops planted along with hard fescue 5/2020 in both locations.

2019 MN-HD Hard Fescue Establishment with Nurse Crop
Roseau Location

TRT#	Variety	Nurse crop	Seed Yield(#/acre)
			2021
1	MN-HD	alone	1433
2	MN-HD	Spring wheat	983

Hard fescue planted 10/30/2019. Spring wheat planted in trt#2- 5/2020.

No crop planted in trt#1 in 2020.

2019 Fine Fescue Establishment with Winter Wheat
St. Paul Location

Species	Variety	Nurse crop	Seed Yield(#/acre)
			2021
hard fescue	MN-HD	alone	1181
hard fescue	MN-HD	winter wheat	802
Chewings	Radar	alone	971
Chewings	Radar	winter wheat	876

Fine fescues planted with winter wheat or alone 10/2019

Locations:

Roseau-Magnusson Research Farm

Rosemount-Umore Park-Forage Hill

St. Paul- St. Paul campus U of Mn. TROE

*Data courtesy of Dr. Florence Sessoms-University of Minnesota

Table 25.

2020-21 Tall Fescue Management Trial
Tveit/Ravndahlen Farm- North of Roosevelt Mn

TRT#	Residue Treatment	Total Fertilizer Applied	Nitrogen Fertilizer Timing	Seed Yield #/acre	Height(in) Harvest
1	Late chop	90-80-90-10s	90#N fall	694	27
2	Late chop	120-80-90-10s	50N fall+70N spring	863	29
3	Late chop	160-80-90-10s	90N fall+70N spring	948	28
4	Late chop	160-80-90-10s	50N fall+110N spring	901	29
5	Bale only	90-80-90-10s	90#N fall	707	29
6	Bale only	120-80-90-10s	50N fall+70N spring	781	29
7	Bale only	160-80-90-10s	90N fall+70N spring	1095	31
8	Bale only	160-80-90-10s	50N fall+110N spring	966	31
LSD @ 5% Level				157	1
CV(%)				12	3

Experimental Design-RCB w 4 reps Variety=Foxhound

Late Chop= TRT# 1-4= Bale residue after harvest 8/10 2020 and clip 3" and bale off 9/9/2020

Bale Only=TRT#5-8= Bale residue after harvest 8/10/2020

Fall fertilizer applications (including all P - K and Sulfur)-9/10/2020

Spring nitrogen fertilizer applications-4/23/2021

Yield Mean of Residue Management Treatments-

Late Chop= 852#/acre

Bale Only= 887#/acre

Yield Mean of Fertility Management Treatments-

90#N fall = 700#/acre

50N fall+70N spring= 822#/acre

90N fall+70N spring= 1022#/acre

50N fall+110N spring= 934#/acre

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Table 26.

2020-21 Tall Fescue Fertility Trial
Magnusson Research Farm-Roseau, Mn

trt#	Total Fertilizer Applied	Additional Fertilizer Fall/spring	Seed Yield #/acre	Height(in) Harvest	RCI ¹		
					5/24/21	6/9/21	Harvest ¹
1	17-40-40-10s	0	313	20	144	173	145
2	120-40-40-10s	60 / 60	1137	27	487	629	305
3	120-40-40-10s	0 / 120	1075	27	454	710	351
4	120-40-40-10s	120 / 0	1155	26	368	554	272
5	160-40-40-10s	80 / 80	1251	24	540	715	291
6	160-40-40-10s	0 / 160	1039	25	481	723	430
7	80-40-40-10s	0 / 80	779	25	396	534	307
8	120-40-40-40s	60+30s / 60	1177	27	489	641	263
LSD @ 5% Level			209	3	98	106	70
CV(%)			14	8	15	12	16

Experimental Design-RCB w 4 reps Variety=Turfway

¹RCI scored in harvested area. May be an indication of residual nitrogen after harvest

17-40-40-10s applied to all plots 9/11/2020

Fall N application- 10/13/2020 Spring applications= 4-27-2021

Table 27.

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

Planting/Establishment Treatment	Seed Yield #/acre	Height(in) Harvest
Spring wheat 120#/ac & tall fescue 5/21/2020	1317	28
Spring wheat 75#/acre & tall fescue 5/21/2020	1324	26
Spring wheat only 120#/ac 5/21--- tall fescue 8/20 into stubble	1081	27
Tall fescue only 5/21/2020	1571	27
Tall fescue only 7/17/2020	1159	26
	LSD @ 5% Level	269
	CV(%)	13
		7
Experimental Design-RCB w 4 reps	Tall fescue Variety=Turfway	
Tall fescue seeded at 6#/acre	Wheat Variety=Linkert	

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Table 28.

**2021 Tall Fescue Growth Regulator Trial
Magnusson Research Farm**

Treatment	Rate+Adjuvant	Seed yield #/acre	Height(in) Harvest
Apogee	8oz.+ .25%NIS+2.5%- 28%N	1473	22
Palisade	16oz+.25%NIS	1357	25
no treat		1449	29
	LSD @ 5% Level	NS	3
	CV(%)	11	7

Experimental Design-RCB w 4 reps
Harvest date 7-15-2021
Apogee 8oz.+ .25%NIS(.24pt/ac.)+2.5%- 28%N(2.4pt/ac.)
Palisade EC 16oz+.25%NIS(.24pt/acre)
Applications 6/9/21- 11am with 10' bike sprayer @ 12GPA
Wind E12mph-84%RH -Pcldy-71F
GH--9-12" 30% heading

Table 29.

**2021 Tall Fescue Fungicide Trial
F3 Magnusson Research Farm**

Treatment	Rate+Adjuvant	Seed yield	Height(in)
		#/acre	Harvest
Priaxor	6oz+.25%NIS	1391	28
Quilt Excel	12oz+.25%NIS	1267	26
No Treatment		1394	27
LSD @ 5% Level		NS	NS
CV(%)		6	4

Experimental Design-RCB w 4 reps

Applications made 6/25/2021 10am west 2-6mph

fully headed and mid pollen shedding

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Table 30.

**2021 Callisto Applied to Per.Ryegrass
Magnusson Research Farm**

Treatment	Rate	adjuvant	Seed yield	Ht.(in.)	%Germ ¹
			#/acre	Harvest	
Callisto	6 oz.	1% Destiny+2.5%AMSOL	929	15	92
	3 oz.	1% Destiny+2.5%AMS(AmSol)	1118	15	
	3 oz.	1% Destiny+2.5%-28%UAN	1050	15	
No treat			1104	16	93
LSD @ 5% Level			149	NS	
CV(%)			7	5	

Experimental Design-RCB w 3 reps

Variety-Arctic Green

Applications- 5/27/2021 45F 10-15ENE 45%RH 4-6" 1-2nodes tall fescue 4-7" 1node

Table 30a.

**2021 Callisto Applied to Tall Fescue
Magnusson Research Farm**

Treatment	Rate	adjuvant	Seed yield	%Germ ¹
			#/acre	
Callisto	6 oz.	1% Destiny+2.5%AMSOL	1104	97
	3 oz.	1% Destiny+2.5%AMS(AmSol)	1157	
	3 oz.	1% Destiny+2.5%-28%UAN	1077	
No treat			1163	96
LSD @ 5% Level			NS	
CV(%)			19	

Experimental Design-RCB w 3 reps

Variety-Turfway

Applications- 5/27/2021 45F 10-15ENE 45%RH 4-6" 1-2nodes tall fescue 4-7" 1node

¹%Germination - Harvested seed from selected treatments - germination results

Trade		
Name	Formulation(# AI/gallon)	Rate per acre+adjuvant
Quilt Xcel	1.02#PROPICONAZOLE + 1.18#AZOXYSTROBIN	12oz+1Qt Preference/100gal.
Priaxor	1.39#FLUXAPYROXAD +2.78# PYRACLOSTROBIN	6oz.+1Qt Preference/100gal.
Callisto	4# mesotrione	3/6oz/acre
Preference(NIS)	.25%	1 Qt./100 gallons
Destiny(MSO)	1%	1 gallon/100 gallons
AmSol 2.5%	(1 gallon=3.4#AMS)	2.5 gallons(8.5#) /100 gallons
28%N	2.5%	2.5 gallons/100 gallons

Table 31.

2021 P & K Large Plot Fertility Wheat Trials**West Plant-Northern Resources and Jason / Greg Braaten Farms /Slater****2021 Wheat**

Treatment	West				Soil Test Levels 9-2021								West Plant	
	Braaten	Plant	Slater	Mean	West		West		West		West		Ht(in)	RCI
	Yield	Bu./Acre			Braaten	Plant	Mean	Braaten	Plant	Braaten	Plant	Braaten	Plant	Harvest
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		West		West	
	Braaten	Plant	Slater	Mean	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant
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	93	71	70	68
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	86	58	65	63
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	12	17	18	5
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	9	12	13	4
CV(%)	6	5	7	4	3	2	6	6	8	6	5	4	6	6	7	2	12	6	6	11	12	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	
	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant	Braaten	Plant
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
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
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
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
CV(%)	9	27	31	18	8	6	41	0	4	8	10	12	16	17	9	9	6	8	4	1	5	6

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

Treatment	West		West		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	Braaten	Plant	Braaten	Plant
Normal(1)	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
Plus 50(2)	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
LSD @5% level	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
LSD @10% level	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
CV(%)	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

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

Northern Resources Tissue Tests take 7/20/20

Seeding Date-

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

Braaten-- 5/22/2020

Northern Resources--6/2/2020

Slater--5/18/2020

Table 34a.

**2020 Rye and Winter Wheat P and K fertility
Magnusson Research farm**

TRT#	Crop	Fertilizer	Yield ¹	Test wt.			Harvest heading		soil test post harvest 8-17-2021						Tissue Sample 5/25/2021					
		Added	Bu./acre	#/Bu.	Frost ²	Breakage ³	Ht(in.)	Date	OM	N ppm	P-O ppm	K ppm	Ca ppm	Mg ppm	%N	%P	%K	%S	%Ca	%Mg
1	Jerry-ww	0	83	62.0	0	0.0	39	13-Jun	3.5	29	7	107	2754	1104	4.6	0.29	3.58	0.32	0.30	0.31
2	Jerry-ww	0-20-20	83	61.7	0	0.0	39	13-Jun	3.5	23	10	113	2794	1108	4.6	0.28	3.36	0.30	0.32	0.30
3	Jerry-ww	0-40-40	82	61.9	0	0.0	41	13-Jun	3.5	32	14	116	2865	1167	4.6	0.31	3.49	0.31	0.30	0.30
4	Jerry-ww	0-60-60	88	61.7	0	0.0	39	13-Jun	3.4	27	14	120	2813	1074	4.9	0.33	3.58	0.31	0.31	0.28
5	Jerry-ww	0-80-80	85	61.9	0	0.0	39	13-Jun	3.4	23	19	121	2839	1122	4.6	0.33	3.56	0.30	0.30	0.29
6	Rymin rye	0	85	56.5	13	2.0	51	1-Jun	3.5	12	7	110	2771	1103	3.4	0.32	3.43	0.23	0.27	0.29
7	Rymin rye	0-20-20	88	56.5	15	2.3	52	2-Jun	3.4	10	10	114	2846	1088	3.5	0.32	3.07	0.22	0.25	0.27
8	Rymin rye	0-40-40	86	56.7	8	3.0	52	2-Jun	3.5	10	10	111	2870	1074	3.4	0.33	3.34	0.21	0.27	0.29
9	Rymin rye	0-60-60	91	56.5	15	3.0	50	1-Jun	3.4	11	14	114	2781	1093	3.3	0.33	3.29	0.20	0.26	0.29
10	Rymin rye	0-80-80	83	56.5	13	3.5	49	1-Jun	3.3	13	20	106	2772	1050	3.7	0.37	3.46	0.23	0.28	0.29
11	KWS Serafino rye	0	123	57.4	14	0.5	44	4-Jun	3.6	12	7	112	2868	1051	3.5	0.29	3.16	0.22	0.28	0.24
12	KWS Serafino rye	0-20-20	133	57.4	13	1.5	44	4-Jun	3.4	21	11	105	2850	1079	3.3	0.31	3.16	0.22	0.26	0.26
13	KWS Serafino rye	0-40-40	137	57.7	12	0.5	45	4-Jun	3.4	17	10	113	2824	1066	3.3	0.32	3.13	0.22	0.27	0.27
14	KWS Serafino rye	0-60-60	139	57.8	13	1.0	44	3-Jun	3.1	11	13	106	2772	1093	3.4	0.35	3.35	0.21	0.26	0.27
15	KWS Serafino rye	0-80-80	140	57.7	15	0.5	44	3-Jun	3.4	12	29	110	2832	1103	3.3	0.35	3.37	0.22	0.27	0.27
LSD @5% level			10	0.5	12	1.2	2	1	NS	13	12	10	NS	NS	0.4	0.04	0.36	0.02	0.04	0.03
CV(%)			7	0.6	94	69	4	10	8	53	68	7	6	8	7	10	8	7	12	9

Experimental Design=RCB w 4 reps

Soil test 9/2020	0-6"	6-24"	Total	Soil test depth = 0-6"						
	nitrate	nitrate	nitrate	P	K	s	zn	%OM	PH	%cce
	9	9	18	5L	107M	28M	.26VL	1.9L	8	.9VL

XX

Table 34b.

**2020 Serafino Hybrid Rye Nitrogen Rate Trial
Magnusson Research farm**

TRT#	Nitrogen Rate	Yield ¹	Test wt.			Harvest heading		Tissue Sample- flag leaf Early heading 6-7-2021						
		Bu./acre	#/Bu.	Frost ²	Breakage ³	RCI ⁴	Ht(in.)	Date	%N	%P	%K	%S	%Ca	%Mg
1	0	131	57.8	10	0.5	357	44	3-Jun	3.9	0.23	1.27	0.3	0.97	0.56
2	40-0-0	138	57.9	13	1.0	477	44	3-Jun	4.1	0.23	1.25	0.31	0.97	0.56
3	80-0-0	141	57.7	20	0.5	455	43	4-Jun	4.5	0.24	1.25	0.33	0.95	0.59
4	120-0-0	138	57.9	17	0.8	478	42	4-Jun	4.5	0.25	1.26	0.33	1.00	0.61
5	160-0-0	148	58	10	0.0	511	43	4-Jun	4.6	0.25	1.50	0.34	1.07	0.61
6	200-0-0	132	58	15	0.0	443	44	4-Jun	4.8	0.26	1.44	0.35	1.03	0.59
LSD @5% level		10	NS	NS	NS	85	NS	1	0.3	0.02	NS	0.03	0.11	NS
CV(%)		5	0.4	104	186	12	4	6	5	5	14	6	8	10

Experimental Design=RCB w 4 reps

Soil test 9/2020	0-6"	6-24"	Total	Soil test depth = 0-6"				
	nitrate	nitrate	nitrate	P	K	%OM	PH	%cce
	10	15	25	10M	128M	2.5L	8.2	1VL

¹-Yield adjusted to 12% moisture

²-Frost damage 6/10-(white heads)- % of total

³-Stem breakage 7/12- 0=none;5= >30% stem breakage. Broken stems may not be picked up with combine

⁴-RCI 5-18-21=Relative chlorophyll index-higher number has higher relative amount of chlorophyll than lower number

Planted 9-15-21

Fertilizer applied 4/25/21

Harvested 7/29/2021

Past crop-soybeans in 2020

Table 35.

Armyworm Moth Trapping Project in Roseau County Summary Report - 2021

Table 1. 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.