

Perennial Ryegrass Production in Minnesota

**Canadian Forage Seed Conference
Edmonton, Alberta
February 25th, 2020**



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Presentation Outline

- **Brief history of grass seed industry in northern MN**
- **Current grass seed research**
- **Theoretical ryegrass seed yields**
- **Ryegrass growing degree days (GDD)**
- **Perennial ryegrass economics**
- **Ryegrass stand establishment/fertility**
- **Pest management**
- **Management strategies - high yield ryegrass seed yields**

Where Are We Located?

State of Minnesota



Roseau County, MN



Brief History of the Seed Industry in MN

- In the 1930's to 50's - Legume seed was the focus
 - ❖ Alfalfa, red clover, alsike clover, sweet clover
- In the 1950's to 70's - Legume seed, Kentucky bluegrass, birdsfoot trefoil, timothy and reed canarygrass
 - ❖ U of MN released 'Park' Kentucky bluegrass in late 50's
- In the 1970's to early 2000's - Kentucky bluegrass, timothy, Kura clover, birdsfoot trefoil, reed canarygrass, native grasses, fescues, switchgrass and bio-energy crops
 - ❖ U of MN released 'Arctic green' perennial ryegrass
- Today - Perennial ryegrass, Kernza, native grasses, fescues
 - ❖ U of MN hard fescue MNHD, Kernza (intermediate wheatgrass)

U of MN Turf Seed Research

U of MN Research Personnel

- **Dr. Nancy Ehlke - Ryegrass breeding and management**
- **Dr. Eric Watkins - Fescue breeding program and turf grass management**
- **Mr. Donn Vellekson - Magnusson Research Farm Manager**
- **Dr. Dave Grafstrom - MN Turf Seed Council and U of MN Magnusson Farm**

U of MN Magnusson Research Farm



Current Turf Seed Research Projects

- **Perennial ryegrass breeding and management**
 - ❖ Variety improvement, fertilizer efficiency, herbicides, growth regulators, straw and residue management, fungicides
- **Hard fescue breeding and management**
 - ❖ MNHD seed increase, fertility, pest and residue management
- **Development of a perennial grain crop - Kernza**
 - ❖ Improved seed size & quality of intermediate wheatgrass
- **Renewed interest in Kentucky bluegrass**
- **Tall fescue management**

U of MN Research - Grass Seed Crops in Early Stages of Development

Kernza



MNHD Hard Fescue



Record Crop Yields

- **Corn: 616.2 bu/ac - David Hula, Virginia,**
- **Soybeans: 171 bu/ac - Randy Dowdy, Georgia**
- **Winter Wheat: 211.5 bu/ac - Rick Pearson, Idaho**
- **Spring Wheat: 180.77 bu/ac - Derek Friehe, Washington**
- **Canola: 5,680 #/ac - Tim Lamyman, UK**

- **Perennial ryegrass seed yields?**



What Are Top-End Perennial Ryegrass Seed Yields on Your Farm?

**What are the major factors/s that limit seed
production in your area?**



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Theoretical Seed Yield for Perennial Ryegrass

Maximum seed yield 10,000 #/ac

Light seed 3,500
#/ac

Florets not pollinated 3,500 #/ac

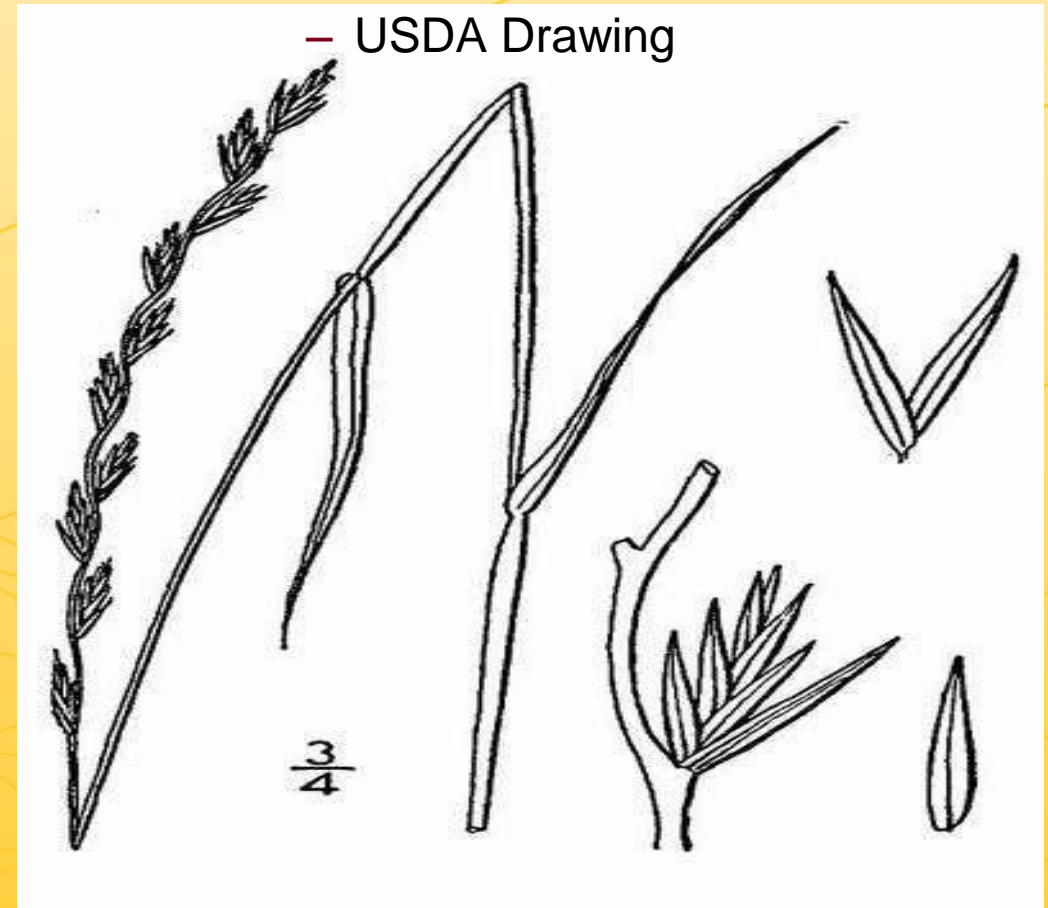
Shattered seed
1,000 #/ac

Actual field harvest 2,000 #/ac

Oregon State University Data

Yield Components: Perennial Ryegrass Seed Production

- 12,022,560 culms/acre
- 21 spikelet's/spike
- 9.4 florets/spikelet
- 0.213 seeds/floret
- 0.000000419 pounds/seed
- 2,215 pounds/acre
- Oregon State University Data



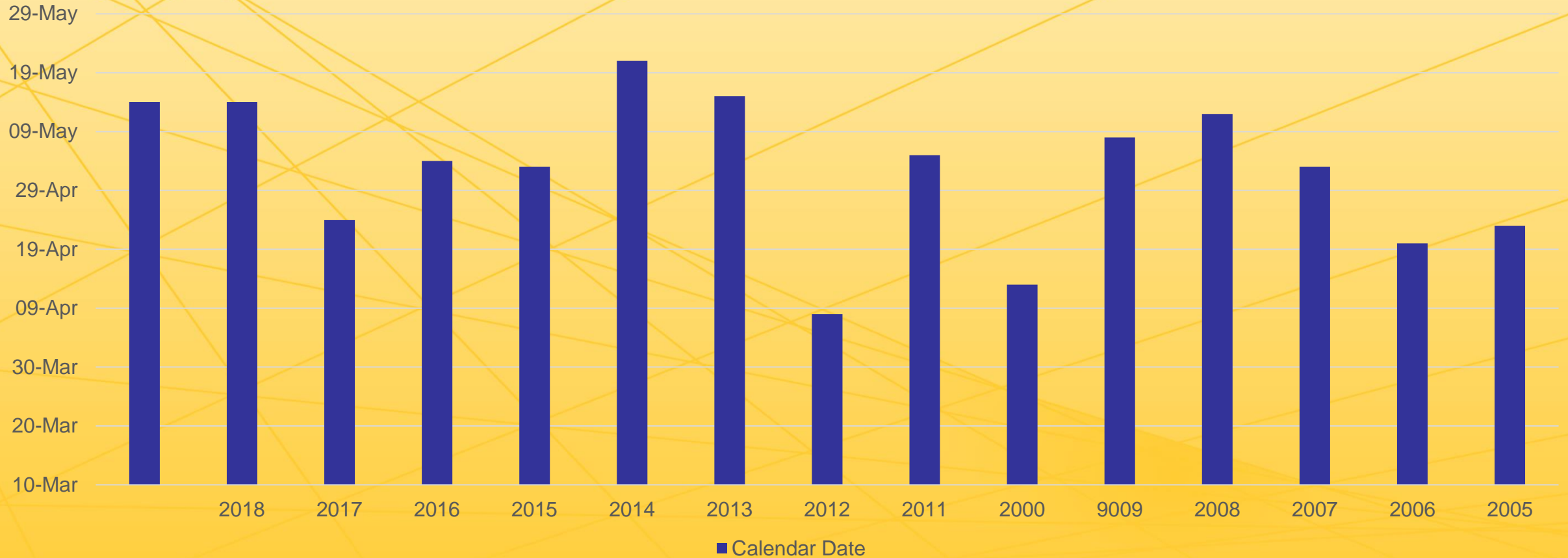
Documented Perennial Ryegrass Yields

- Oregon data suggests over 2,000 #/acre
- MN average 800 #/ac
- High 20% 1,200 #/ac
- In 2018, selected MN ryegrass growers had yields over 1,500 #/ac
- In 2019, the U of MN research farm had small plot yields over 2,240 #/ac



Lake of the Woods: Ice-out Dates; 2005-2019

Median Date 5/3; Early 4/8/12, Late 5/21/14



Growing Degree Day (GDD) in Perennial Ryegrass Grown in Northern MN

What is GDD?

- Used to estimate the growth and development of plants and insects
- $GDD = (T_{max} + T_{min})/2 - T_{base}$
- T_{max} = Daily max temp
- T_{min} = Daily min temp
- T_{base} = Base temp for plant/insect
- T_{base} for ryegrass is 32 F

GDD Example

- High & low temp was 65 and 45 F
- $(65+45)/2 = 55 - 32 = 23$
- 23 GDD were accumulated for the day
- Begin to accumulate GDD after snow melt in spring
- If frost kills green ryegrass vegetation after green up, may have to adjust GDD for year



Perennial Ryegrass GDD in MN

GDD Use in MN

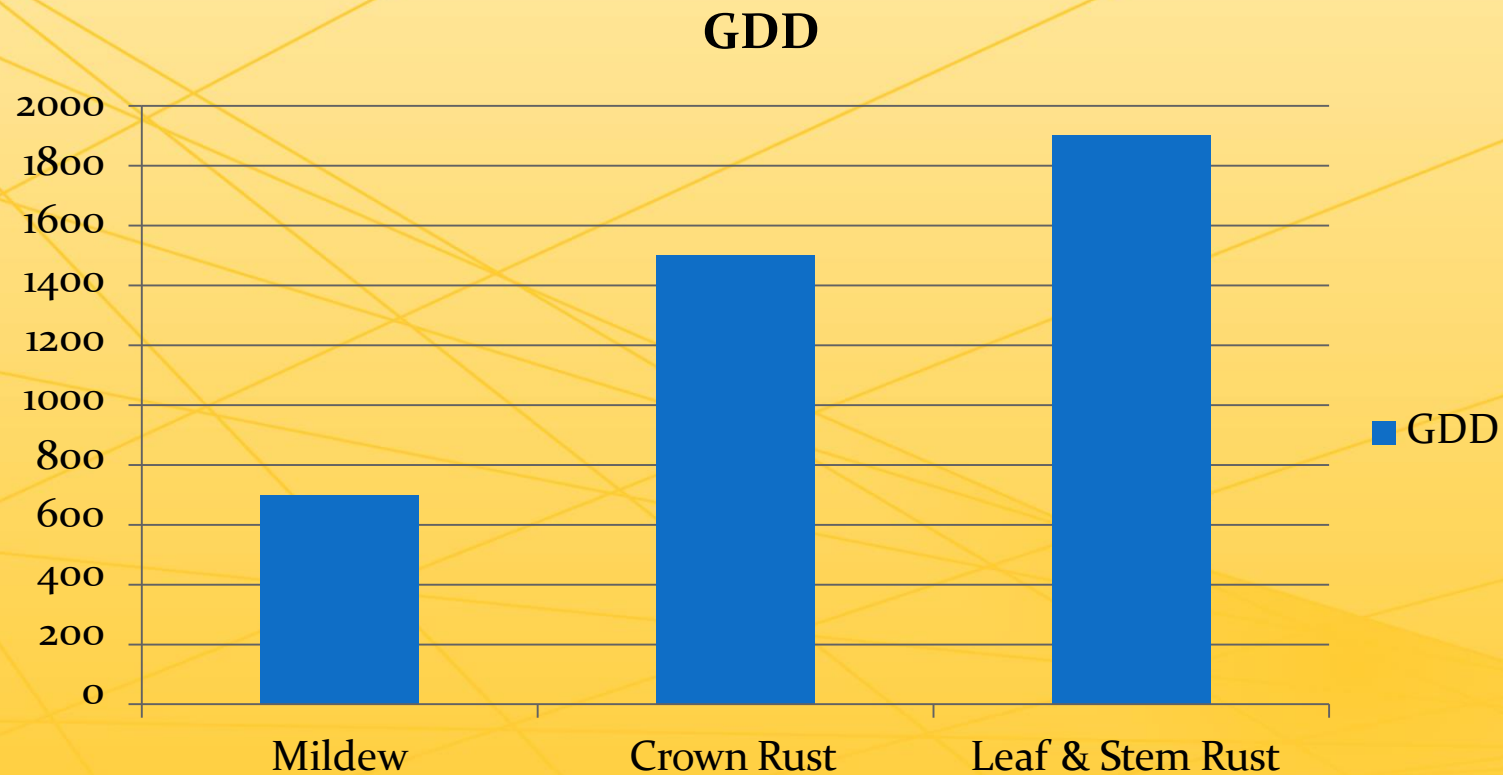
- Works well to predict ryegrass growth stages
- Can be used to predict pest outbreaks (mildew in bluegrass and rust in ryegrass)
- The big limitation of the GDD in ryegrass seed production it doesn't account for level of plant growth (e.g. thin, medium or lush)

Specific Applications

- Herbicide timings
- Growth regulator schedules
- Fertilizer timings
 - ❖ Spring applications
 - ❖ Splits - dry, or liquid
- Monitoring for pest outbreaks
 - ❖ Powdery mildew
 - ❖ Crown & leaf and stem rust
 - ❖ Grasshoppers & armyworms



Average GDD Accumulation to Onset of Leaf Diseases in MN Turf Seed Production



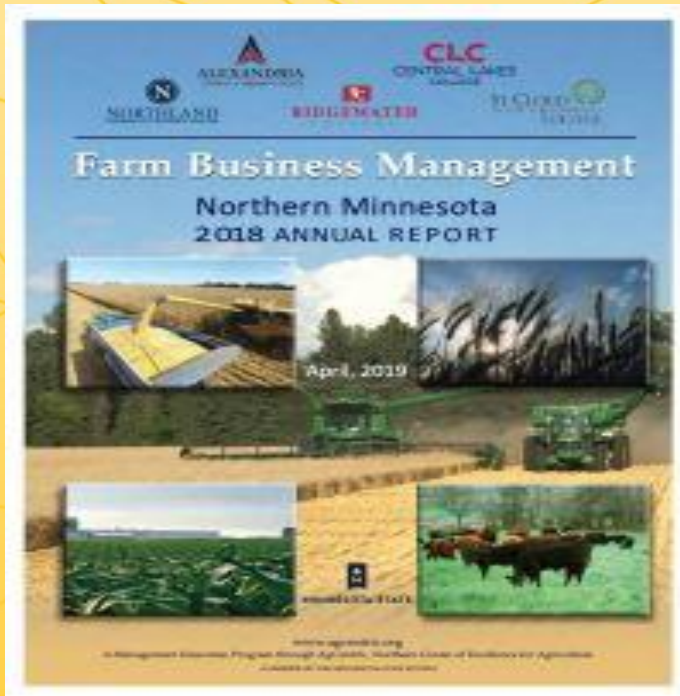
Perennial Ryegrass Growth Stage by GDD

<u>Plant Stage</u>	<u>GDD</u>
2-3 Leaf	400 - 650
1-2 Nodes	700 - 850
2-3 Nodes	900 - 1050
Boot Stage	1100 - 1250
50% Headed	1300 - 1550
Pollen shed	1600 - 1750
Swathing	2750 - 2900

Averaged over years & locations

Perennial Ryegrass - a Profitable Crop?

Farm Business Management



What do the Numbers Tell Us?

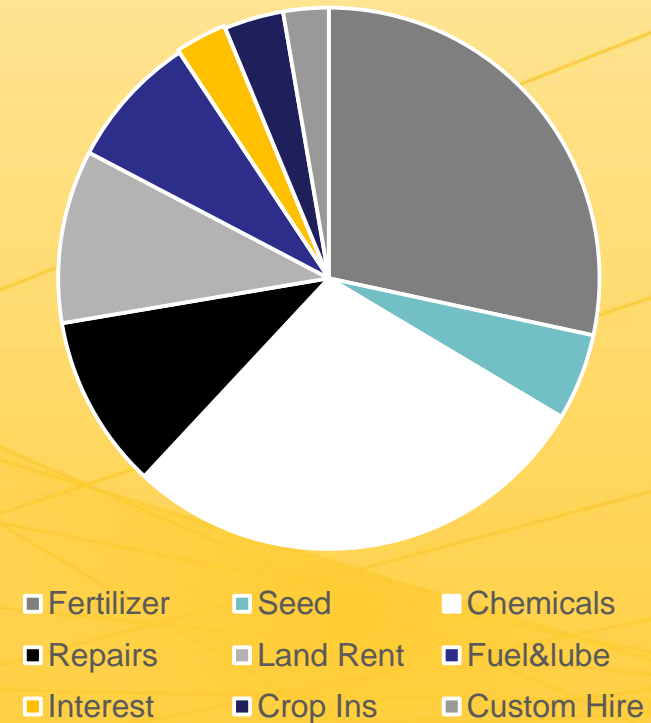
- Farm Income Statements
- Profit & Loss Statements
- Crop Enterprise Analysis
- Cost of Production
- Breakeven Price
- Impact of Average Yields
- What about Producers that are in the top 20%?

Ryegrass Direct Costs = \$286.65/acre

Source: 2018 NCTC FBM Annual Report

- Fertilizer = \$92.30 (32%)
- Chemicals = \$47.37 (16.5%)
- Repairs = \$33.83 (11.8%)
- Land Rent = \$33.63 (11.7%)
- Fuel & Lube = \$26.04 (9.1%)
- Seed = \$16.82 (5.9%)
- Crop Insurance = \$11.50 (4%)
- Op Interest = \$9.96 (3.5%)
- Custom Hire = \$8.81 (3.1%)

Ryegrass Direct Costs



Estimated 2019 Cost/Returns

01/8/19

2019

2019

2019

Projected	Ryegrass	Wheat	Soybeans
Yield per Acre	800	60	37
Price/ Unit	\$ 0.60	\$ 6.14	\$ 8.56
Gross Income	\$480.00	\$368.4	\$ 316.72
Total Costs	\$381.50	\$351.33	\$ 289.37
Profit Per Acre	\$ 98.5	\$ 17.07	\$ 27.35
Profit Margin	25.8%	4.9%	9.5%
BEP	\$ 0.48	\$ 5.86	\$ 7.82



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Uniform Ryegrass Stand is the Goal

Good Ryegrass Stand



Gaps in Ryegrass Stand



Factors Affecting Perennial Ryegrass Seed Yields

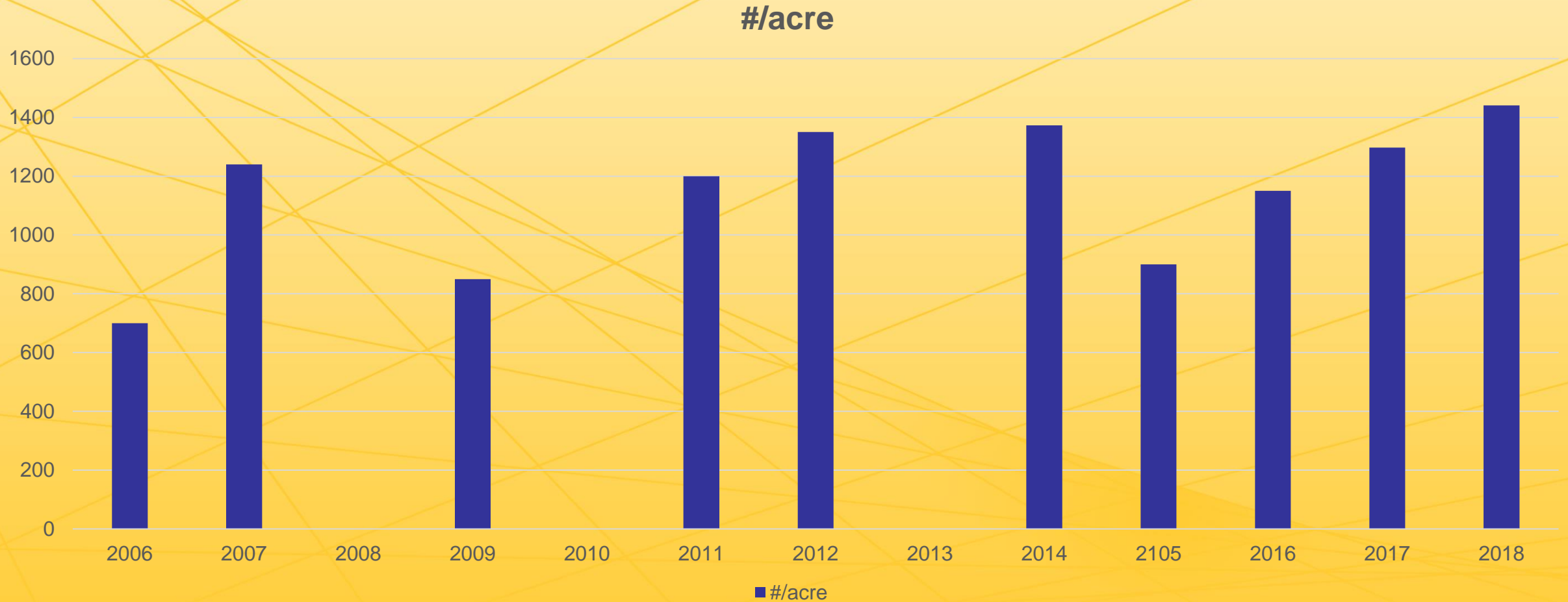
- Stand losses (winterkill, heavy straw...)
- Erratic stands (lack of uniformity)
- Time of seeding (spring or fall)
- Fertility (nitrogen losses, sulfur, others?)
- Weed control
- Control lodging
- No rust control
- Harvest & cleaning losses
- Storage losses

Perennial Ryegrass Seed Yield Influenced by Residue and Seeding Date in 2008

	<u>Tilled Ground</u>		<u>Wheat Stubble</u>	
Seed Date	Yield (#/ac)	Dry matter (tons/ac)	Yield (#/ac)	Dry Matter (tons/ac)
8/25	736	1.81	1,405	2.96
9/1	599	1.61	1,135	2.71
9/9	545	1.07	714	2.05
9/17	173	1.07	466	1.27
9/22	67	0.92	377	1.08
LSD (0.05)	444	1.10	444	1.10

- Ryegrass seeded at 5 #/ac
- Tilled ground had little residue cover, 10% volunteer wheat
- Ryegrass seeded into wheat stubble after Roundup application and straw harrowed
- Wheat stubble improves ryegrass winter survivability as snow remains on field not blown off
- Tilled ground - more variability in ryegrass stands, higher probability of winter kill, erratic stands

Perennial Ryegrass Variety Trial Seed Yield from 2006 to 2018 - U of MN Mag Farm



Uniform Ryegrass Stands - Challenges

Winter Injury in Tilled Ground

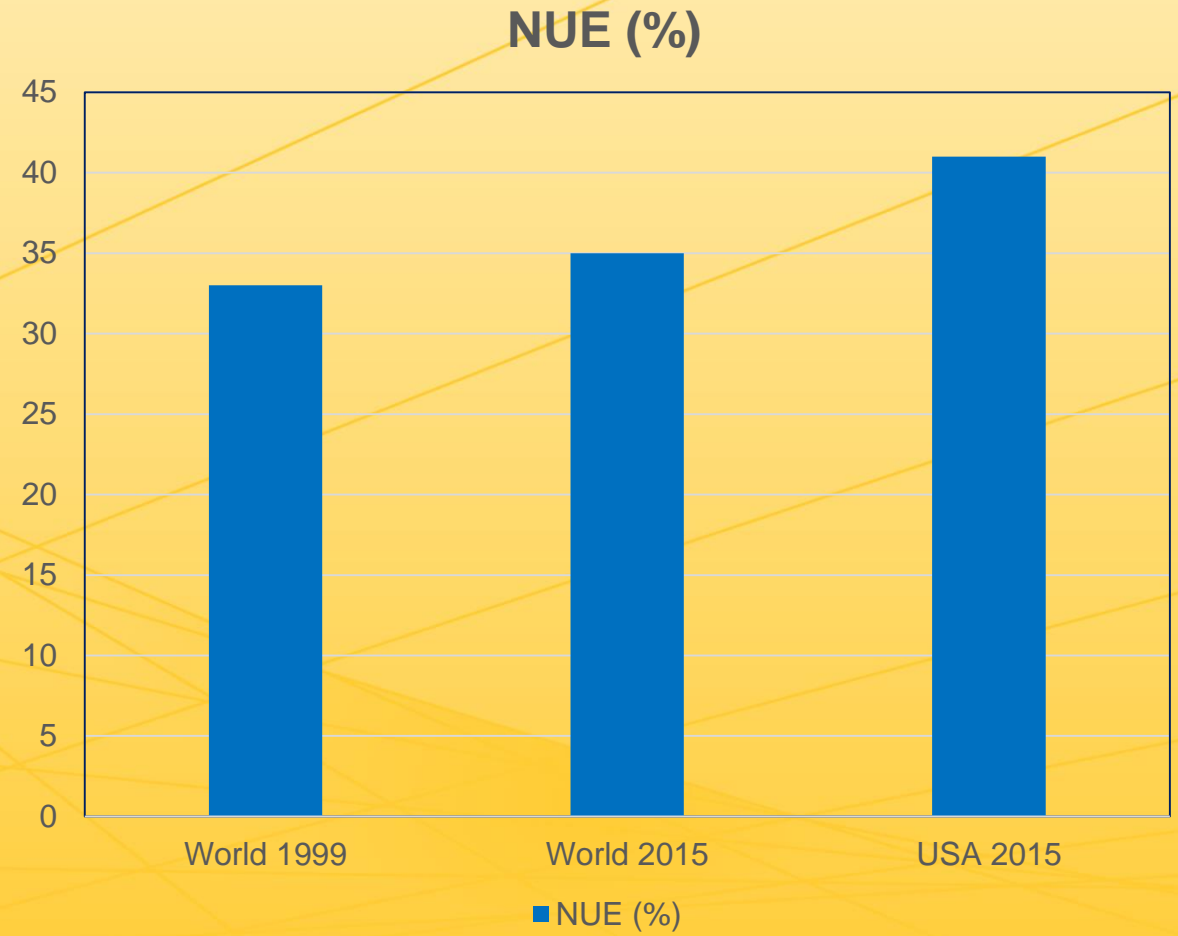


Poor Straw Distribution



Nitrogen Use Efficiency (NUE)

- World NUE in 1999 was 33%
- World NUE in 2015 was 35%
- USA NUE in 2015 was 41%
- Paper titled: World Cereal Nitrogen Use Efficiency June 20, 2019
- Source: Agrosystems, Geosciences & Environment. Authors, Omara et al.



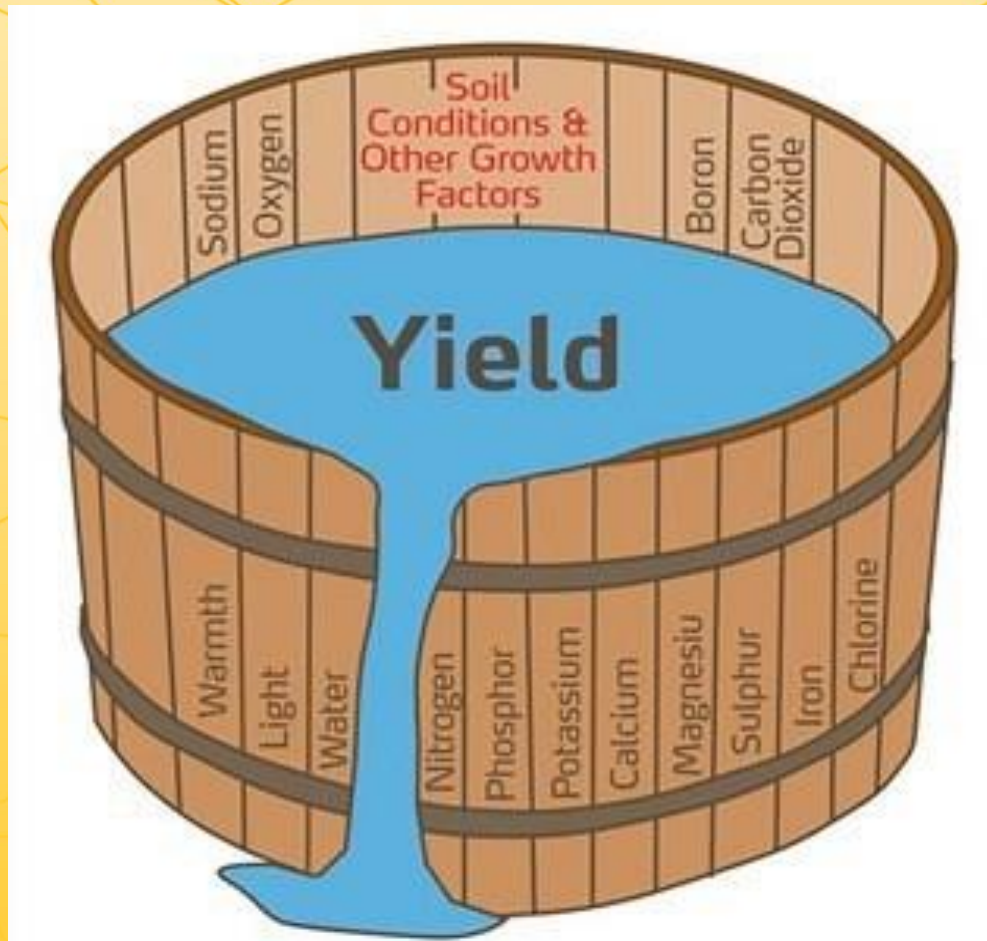
Perennial Ryegrass Fertility

- Nitrogen must be available in the spring at spike initiation 400 GDD
- Perennial ryegrass yields not limited by nitrogen content of 140#/ac, Rolston et al., 2010
- Linear response of seed yield and nitrogen rate, 12.32 #seed for each # of nitrogen, Rolston et al., 2010
- MN moved from 100% of nitrogen fall applied to a split application strategy
- P&K fall applied with 30-50 units of nitrogen
- Remainder of nitrogen spring applied with sulfur (AMS)
- Supplement with liquid nitrogen in-season

Nitrogen Stress on Left?



Fertility Requirement in Ryegrass

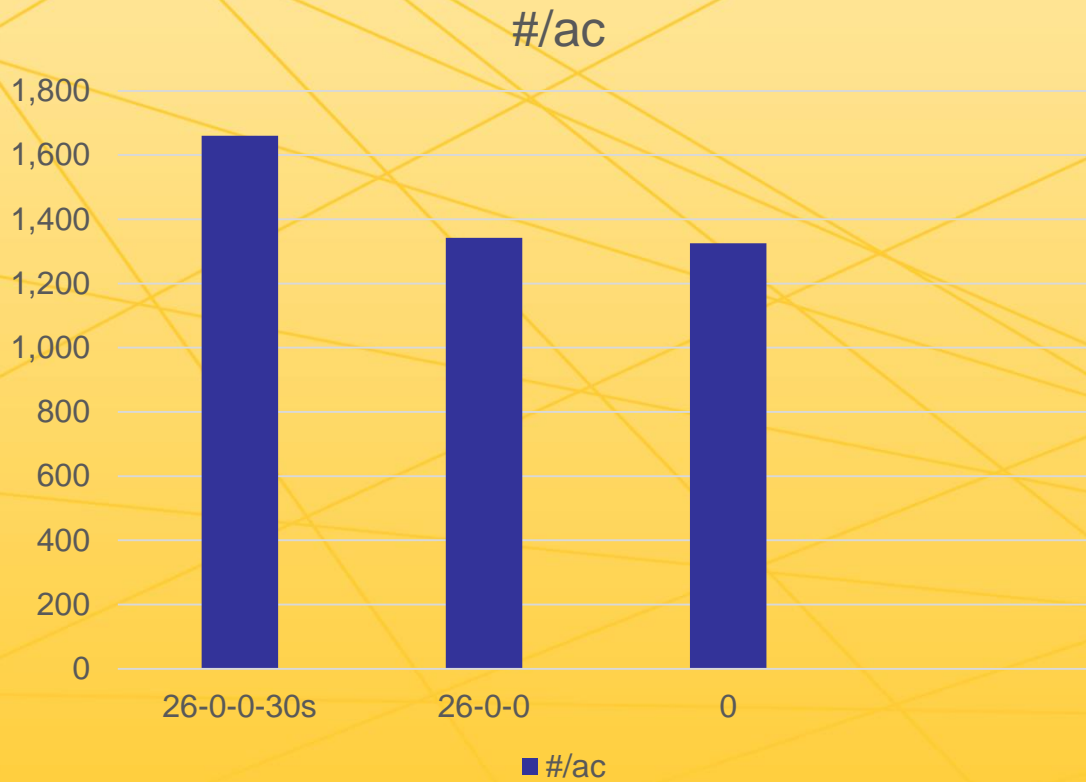


- Law of the minimum
- Barrel stave used to illustrate this concept in plant nutrition
- Justus Von Liebig credited with the idea that yields are capped by most limiting factor
- More may not be better?
- With higher yield goals may find unexpected nutrient shortages



Sulfur in Perennial Ryegrass

Ryegrass Seed Yield



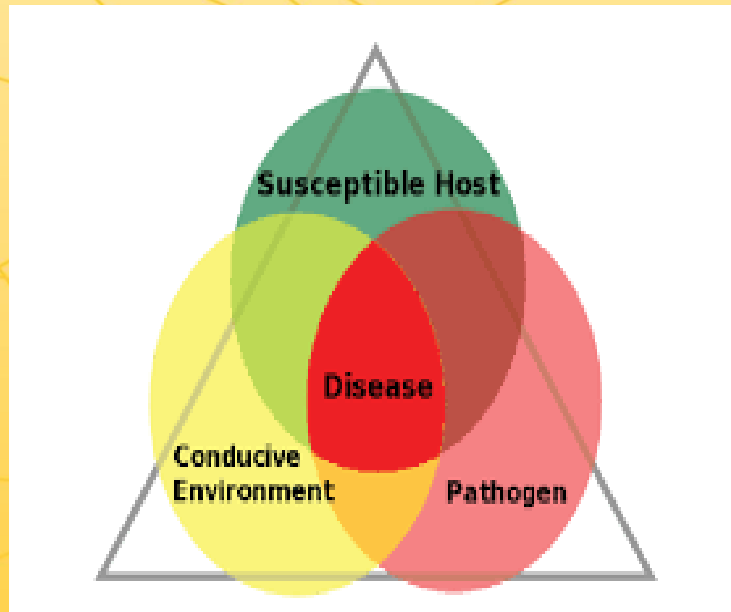
Large On-Farm Trial - 2018

- **Cooperator - Rice Farms Inc.**
- **RCBD with 3 reps**
- **Plot size 48 by 600 feet**
- **3% OM, sulfur 10 ppm (low)**
- **Field fertility**
 - ❖ **8-40-40 on 9/10/17**
 - ❖ **110-0-0 on 5/6/18**
 - ❖ **115 # AMS & 57# 46-0-0 on 5/11/18**
- **Harvest 7/24/18 - >300 #/ac more seed from AMS spring applied**

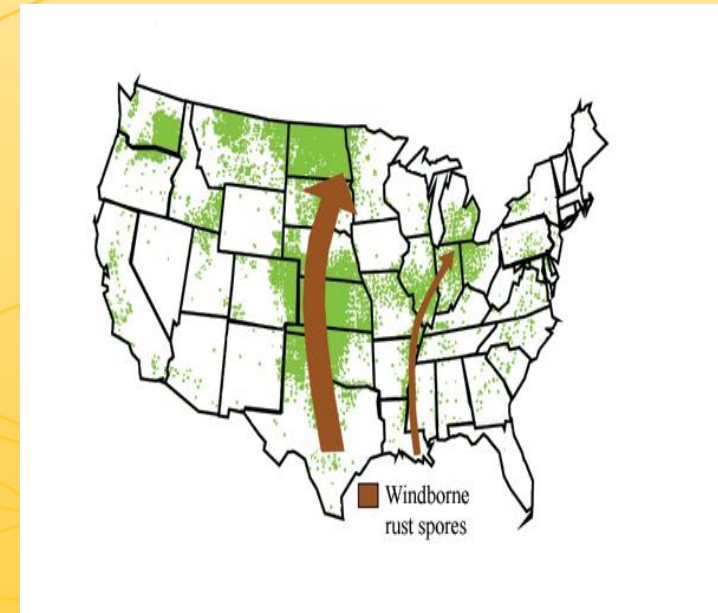


Rust in Perennial Ryegrass

Disease Triangle



Puccinia Pathway



Leaf Diseases in Grass Seed Crops

Powdery Mildew



Crown Rust



Leaf and Stem Rust in Perennial Ryegrass

Head Infection

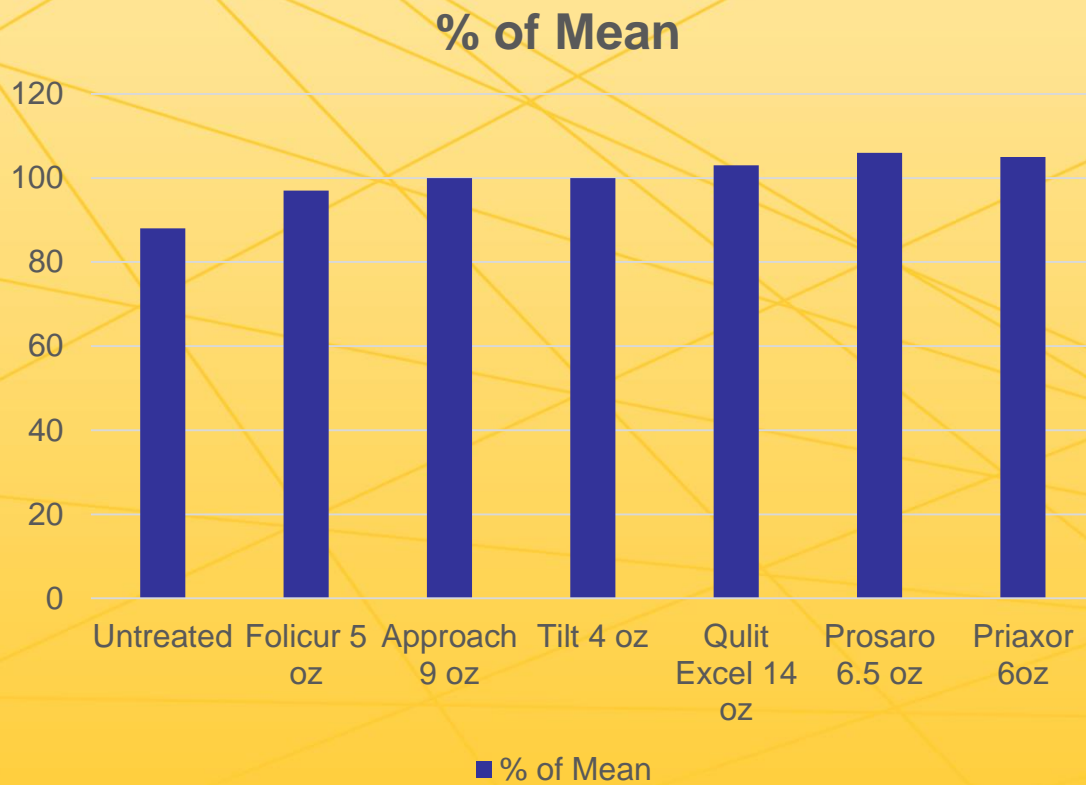


Leaf and Stem Rust



Perennial Ryegrass Fungicide Trial Summary 2016 - 2018

Fungicide Trial Data - % of Mean

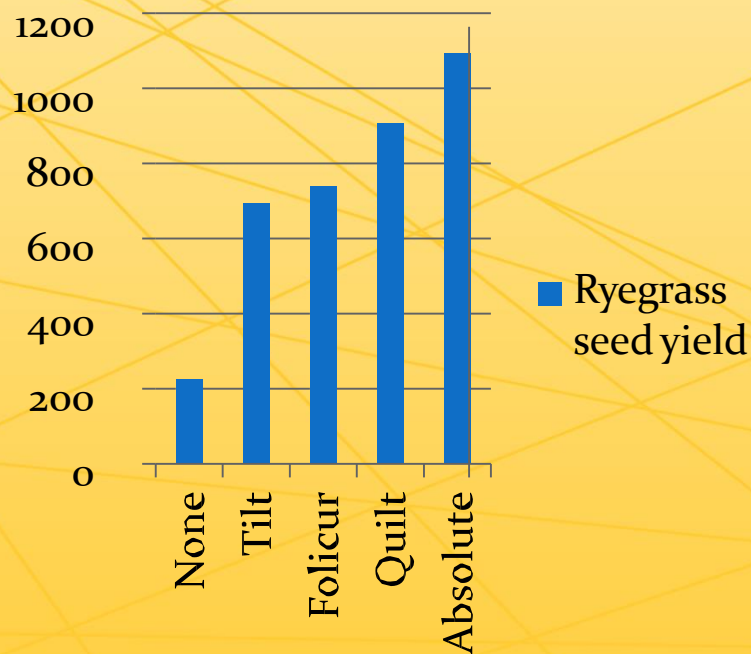


Fungicide Trial Summary

- Perennial Ryegrass Mean Yield
 - ❖ 2018 - 1,387 #/ac
 - ❖ 2017 - 1,675 #/ac
 - ❖ 2016 - 1,301 #/ac
- Data from 6 site years
- Low visible disease pressure
- Fungicides applied to fully headed ryegrass
- Fungicide treated averaged 167 #/ac more seed than untreated

Fungicide Trial in 2010 - Farmer Cooperator, D. Pieper

Ryegrass seed yield



- Treatments applied 6/22/2010
- Heavy leaf & stem rust pressure
- Moderate crown rust
- Folicur & Tilt limited kickback activity
- $LSD (0.05) = 238$



Perennial Ryegrass – Growth Regulators

Growth Regulators in MN

- Apogee (*Prohexadione calcium*)
- Palisade (*Trinexapac - ethyl*)
- Both products reduce lodging by a reduction in cell elongation (inhibits gibberellin synthesis)

Features of Growth Regulators

- Reduce lodging
- Better pollination
- Increase tillering
- Improved seed set
- More efficient swathing/harvesting
- Reduction in small seed/fines

Lodging in Perennial Ryegrass

Growth Regulator Trials

- U of MN trials average yield increase over 200#/ac
- Early lodging promotes vegetative tillering (Rolston 2007)
- Seed yield increased 19.7 #/ac for each delay in days to 50% lodging (Trethewey et.al.)
- Days to 50% lodging good predictor of ryegrass yield

Apogee on Left; No Treat on Right

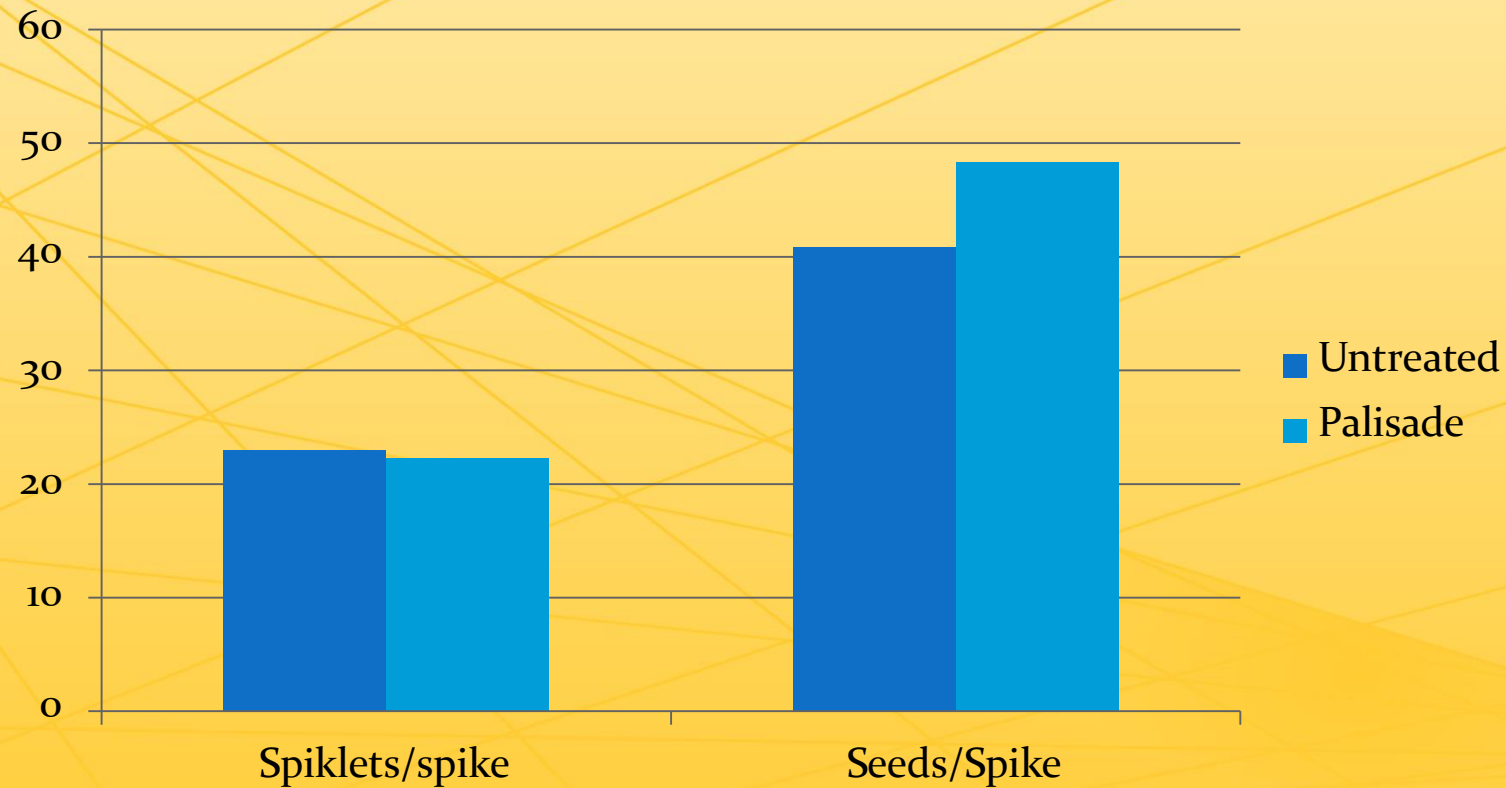


Perennial Ryegrass Seed Yield, Lodging and Plant Height in 2017 & 2018

Treatment	% Mean	Lodging (1-9 score)	Height (in)
Untreated	84	8.5	27
Palisade 0.75 pt	98	6.0	24
Palisade 1.5 pt	101	4.5	20
Apogee 2.5% AMS	104	4.8	19
Apogee 3 gal UAN	102	3.3	20
Apogee 3 gal AMS	110	3.0	21
LSD (0.05)		1.8	2

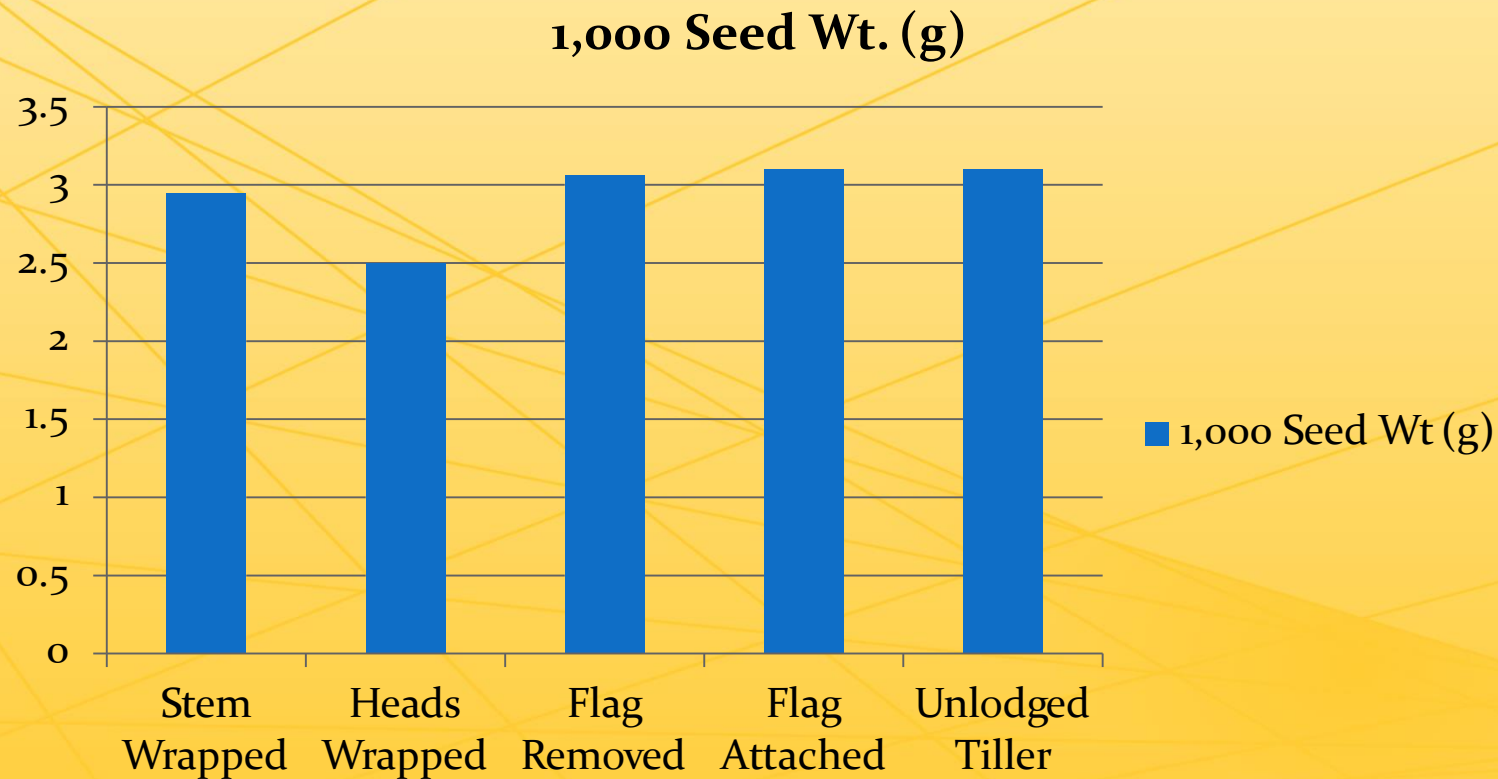
- RCBD with 4 reps
- Ryegrass average seed yield in 2017= 1,731#/ac; 2018=1,137#/ac
- NIS @ 0.25% added to all trts
- Apogee rate = 8 oz/ac
- Trts applied to ryegrass in late boot stage (12-14 inches tall)
- Palisade w/two additives causes injury, especially when dry
- Trend for more seed from 3 gallons AMS vs 2.5% v/v

Perennial Ryegrass Spike Morphology Influenced by Growth Regulators



Chastain et al. 2003

Perennial Ryegrass Seed Weight Influenced by Shading



Trethewey et al. 2010



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Wild Oat and Barnyardgrass Seed



Normal cleanout
approximately 20%

Wild oat and
Barnyardgrass seed will
increase cleanout an
additional 5-10%

800 # yield = \$40/acre

1200#yield = \$60/acre

Mow low areas

Try and leave weed seed in
field

Perennial Ryegrass Seed Yield, Percent Moisture and Test Weight influenced by Cutting Date in 2014

Cut Date	% Mean	%moisture	Test wt. #/bu
7/30	96.9	46	28.5
8/1	92.5	43	29.2
8/3	107.5	40	29.4
8/5	107.5	37	30
8/7	121.7	34	30.2
8/9	93.9	28	31
8/12	88.8	21	30.4
LSD (0.05) CV (%)	6.2 3.4		

- Ryegrass seed yield data in 2014 averaged from two sites
- Average seed yield: 1,358 #/ac
- Seed moisture can decline by >2% points/day
- Sweet spot for cutting ryegrass when seed moistures are in the mid-30's
- Tendency is to cut too early, seed losses of >130#/ac
- Cut too late more shatter loss

Perennial Ryegrass - Management Guidelines at U of MN Mag Farm

- **Ryegrass seeded @ 5-7#/ac with spring wheat**
- **40-40-40 applied after wheat harvest and straw harrowed**
- **Dicamba + 2,4-D (0.75 + 0.75 pt/ac) in September**
- **110-0-0-30s applied in May: 300-600 GDD**
- **Dicamba + 2,4-D (0.75 + 0.75 pt/ac) late May: 600-800 GDD**
- **Grass Herbicide early June: 800-1,000 GDD**
- **Apogee (8 oz/ac) 3rd node to early heading: 1,000-1,300 GDD**
- **Quilt Excel at full head extension: 1,700-1,900 GDD**
- **Swathing 2,700-2900 GDD**

Control the Controllables

We have Some Control

- Crop/variety selection
- Timings of crop inputs
- When purchase crop inputs
- Nitrogen rate & timing
- Pay close attention to details
- DETAILS MATTER!!
- Utilize all management resources
- When to swath

Very Little to No control

- Weather
- In-season input prices
- Pest infestations
- Commodity prices
- Government programs & policies
- Global economy
- Agriculture policy
- Interest rates

Yield Drives Profits

- **Average yields: may result in negative cash flow**
- **Utilize technology (GPS, auto steer, GIS mapping, Satellite, UAS)**
- **Engage entire management team**
- **Regular crop scouting**
- **Understand grass seed plant growth and development, GDD model & pest patterns**
- **Control the controllable**

Summary

- Understand perennial ryegrass growth patterns, stages and pest patterns (GDD model, pest scouting, newsletters)
- Yields drive profits
- Nitrogen, growth regulators and fungicides are key factors to maximize ryegrass yields, assuming uniform stands
- If mother nature smiles, 1,500 #/ac ryegrass seed yields are very possible

Questions



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