Kernza Agronomics Research: A Forever Green Update

Acknowledgments

Team

- UMN: Craig Sheaffer, Jessica Gutknecht, Don Wyse, Nancy Ehlke, Walid Sadok, Colin Cureton, Connie Carlson, Kevin Betts, Donn Vellekson
- Sustainable Agroecology Lab: Katherine Bohn, Dayana Carvalho, Stella Pey, Sienna Nesser, Evelyn Reilly, Garett Heineck, Manbir Rakkar
- Lab Alumni: Galen Bergquist, Michelle Dobbratz, Chris Fernandez, Mitch Hunter, Nicole Tautges
- Farmer Partners Carmen Fernholz, Kaleb Anderson, Dan Honken, Kurt Kimber, Scott Johnson

44% of cropland occupied by • Corn

- Wheat
- Rice

Kernza Perennial Grain



Jerry Glover of The Land Institute: Photo by Jim Richardson

- Relatively large seeds for a perennial grass
- Deep, dense root system
- Tolerant to a wide range of temperature and precipitation patterns

Breeding & Genetics Environmental Agronomy Impacts Food Commercialization Science

Implementation

Environmental Impacts GHG Mitigation Biodiversity Enhancement

Groundwater Protection

Carbon Soil Sequestration Conservation







Grain Harvest







Seeding Date Trial



Seeding Date Trial

| | | | • | | |
|----------|----------|--------------------|--------------------|-------------------|--------------------|
| | | | Roseau, Minnesota | | |
| | | | August 15, 2017 | | |
| | | | September 1, 2017 | | |
| Т | | | September 15, 2017 | | |
| | 1 Frank | \sim | October 1, 2017 | St. Paul, N | Vinnesota |
| ┢ | | | October 15, 2017 | Year 1 | Year 2 |
| | | Salina, Kansas | May 2, 2018 | September 1, 2016 | August 18, 2017 |
| \vdash | | September 6, 2016 | June 1, 2018 | October 1, 2016 | September 1, 2017 |
| | 7 | September 15, 2016 | | December 15, 2016 | September 15, 2017 |
| | | September 29, 2016 | | March 21, 2017 | October 1, 2017 |
| | | October 13, 2016 | | April 1, 2017 | October 15, 2017 |
| F | <u> </u> | November 1, 2016 | | May 1, 2017 | November 1, 2017 |
| | 2 | November 17, 2016 | | | November 17, 2017 |
| | | February 15, 2017 | | | December 1, 2017 |
| | | March 16, 2017 | | | April 1, 2018 |
| | _ | April 13, 2017 | | | May 1, 2018 |
| | | | | | |

Seeding Date Trial







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AGRONOMY, SOILS & ENVIRONMENTAL QUALITY

Intermediate Wheatgrass Grain and Forage Yield Responses to Nitrogen Fertilization Optimum N Fertilizer Rate: 60 – 80 kg ha⁻¹

Jacob M. Jungers,* Lee R. DeHaan, Kevin J. Betts, Craig C. Sheaffer, and Donald L. Wyse

Agronomy Journal · Volume 109, Issue 2 · 2017



What yield components are affected by N fertilizer?

| Yield component | R ² | Р |
|-------------------------------|----------------|---------|
| Tillers m ⁻¹ | 0.001 | 0.42 |
| Spikes m ⁻¹ | 0.13 | < 0.001 |
| Fertile tiller proportion | 0.34 | <0.001 |
| Fertile tiller base mass | 0.04 | < 0.001 |
| Seed mass spike ⁻¹ | 0.21 | < 0.001 |
| Seeds spike ⁻¹ | 0.20 | < 0.001 |
| Individual seed mass | 0.02 | 0.003 |



Fernandez et al., in review

Nitrogen Fertility and Legume Intercropping What yield components are affected by N fertilizer?





Does timing of N fertilization matter?



Can legume intercrops fix N for Kernza uptake?



Can legume intercrops fix N for Kernza uptake?



Nitrogen Fertility and Legume Intercropping Can legume intercrops fix N for Kernza uptake?











Weed Management

| Treatment No. | Herbicide | lb ae/A | Timing |
|---------------|-------------------------|-------------|---------------|
| 1 | 2,4-D Amine 1X | 0.95 | 1 Fall 2019 |
| 2 | 2,4-D Amine 2X | 1.9 | 1 Fall 2019 |
| 3 | Clopyralid 1X | 0.09 | 1 Fall 2019 |
| 4 | Clopyralid 2X | 0.18 | 1 Fall 2019 |
| 5 | Clopyralid 1X + MCPA 1X | 0.09 + 0.50 | 1 Fall 2019 |
| 6 | Clopyralid 2X + MCPA 2X | 0.18 + 1.0 | 1 Fall 2019 |
| 7 | MCPA 1X | 0.5 | 1 Fall 2019 |
| 8 | MCPA 2X | 1 | 1 Fall 2019 |
| 9 | 2,4-D Amine 1X | 0.95 | 2 Spring 2020 |
| 10 | 2,4-D Amine 2X | 1.9 | 2 Spring 2020 |
| 11 | Clopyralid 1X | 0.09 | 2 Spring 2020 |
| 12 | Clopyralid 2X | 0.18 | 2 Spring 2020 |
| 13 | Clopyralid 1X + MCPA 1X | 0.09 + 0.50 | 2 Spring 2020 |
| 14 | Clopyralid 2X + MCPA 2X | 0.18 + 1.0 | 2 Spring 2020 |
| 15 | MCPA 1X | 0.5 | 2 Spring 2020 |
| 16 | MCPA 2X | 1 | 2 Spring 2020 |
| 17 | Nontreated check (NTC) | 0 | |



Harvest Timing – Swathing vs. Direct Combining



Harvest Timing – Swathing vs. Direct Combining

| Swath and | d Combine | Direct Combine | | |
|---|--|---------------------------------|---|--|
| Pros | Cons | Pros | Cons | |
| Flexible harvest timing, anytime after physiological maturity | Must be timed to allow quick windrow drying – no rain for 3 days | Fewer passes, Less equipment | Wetter grain requires drying | |
| Grain may not require mechanical drying | Grain vulnerable to microbial contamination in windrow with rain | | If delayed to allow uniform drying, shattering occurs | |
| Cleaner seed/grain harvest | | | Grain/seed requires more extensive conditioning | |













Rapid drying begins about 450 GDD post anthesis











Maximum dry seed weight at about 900 GDD post anthesis











Maximum grain yield per spike about 600 GDD post anthesis

- Rapid moisture loss begins around <u>450 GDD</u> post anthesis
- Maximum seed dry weight occurs around <u>900 GDD post</u> anthesis
- Maximum grain yield per spike about 600 GDD post anthesis





Plant density, seed head production and grain yields



Plant density, seed head production and grain yields



Reduce plant density by inter-row disturbance



Inter-row cultivation



Inter-row herbicide









Potential mechanism 1 – Photosynthesis rates decline with stand age

Potential mechanism 2 – Changes red:far red light affect flowering









Spring

None

Fall

Spring + Fall





Spring + Fall







Summary

• Summer straw harvest is more profitable than spring or

fall haying

- Fall haying does increase profitability
- Profitability is highest in 15 or 30 cm rows





Termination and Rotation

- How many years should Kernza be in the field as part of a rotation?
- How and when can Kernza be terminated to prevent C losses?
- What are the rotation effects of Kernza on subsequent crops?



Future Research

Interactions among N & P fertilizer, mycorrhizal fungi, and Kernza yields

- Can P fertilization limit lodging and increase grain yields under high N fertilization?
- Does N fertilization affect arbuscular mycorrhizal fungi (AMF) colonization and function?

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- The Land Institute
- The Forever Green Initiative

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Questions

