#### Proceedings of the 5<sup>th</sup> Annual Nitrogen: Minnesota's Grand Challenge & Compelling Opportunity Conference



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### **Improving Nitrogen Mineralization Predictions**



SDSU

Extension

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# Outline

- Introduction and materials and methods
- Q-1) Does incubation length, soil sampling timing, and N fertilization influence PMNan?
- Q-2) Will changes in PMNan due to sampling timing, N rate, and incubation length improve predictability of EONR?
- Q-3) Can using PMNan values in conjunction with other soil-N tests improve corn response predictions?
- Q-4) Can including PMNan with soil-N tests improve N sufficiency indexes?

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Pictures: Minnesota Department of Agriculture

















#### Decomposition of Organic Materials

#### **Nitrogen Fertilizers**

# Organic-nitroge

#### Inorganic-nitrogen NO<sub>3</sub><sup>-</sup> and NH<sub>4</sub><sup>+</sup>

#### Inorganic-nitrogen

# Grain yield with NO nitrogen applied



### 49 site-years in 8 U.S. Midwestern states



# Soil textures varied across the 49 site-years

![](_page_13_Figure_1.jpeg)

# Mean annual temperature increases from 35 to 65°F

![](_page_14_Figure_1.jpeg)

### Precipitation increases from 14 to 52 inches

![](_page_15_Figure_1.jpeg)

# Weather

![](_page_16_Picture_1.jpeg)

Precipitation and temperature

#### N fertilizer treatments created two N response curves

![](_page_17_Figure_1.jpeg)

# **Soil Sampling**

![](_page_18_Picture_1.jpeg)

## Soil characterization

- Texture
- Bulk density
- Organic matter
- Carbon
- Total nitrogen
- pH
- CEC

# Soil nitrate

- Pre-plant (PPNT), 0-36 in.
- V5 (PSNT), 0-24 in.

# **Plant Sampling**

![](_page_19_Picture_1.jpeg)

#### **Plant Sampling**

![](_page_19_Picture_3.jpeg)

**Grain Yield** 

### Anaerobic Potentially Mineralizable Nitrogen Test (PMNan)

![](_page_20_Picture_1.jpeg)

![](_page_20_Picture_2.jpeg)

![](_page_20_Picture_3.jpeg)

#### What's the best PMNan protocol to predict EONR?

- Soil sampling timing: Pre-plant and V5 (5 horizontal leaves)
- Nitrogen Rate: 0 and 160 lbs. ac<sup>-1</sup> (V5 sampling time)
- Incubation length: 7, 14, 28 days

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# **PMNan Increases with Incubation Length**

□ 7-Day □ 14-Day □ 28-Day

![](_page_22_Figure_2.jpeg)

Soil Texture

## Sampling timing can influence PMNan (0-N Check)

![](_page_23_Figure_1.jpeg)

![](_page_23_Figure_2.jpeg)

# PMNan from V5 > PP under higher temperatures

![](_page_24_Figure_1.jpeg)

# Soil and weather conditions influence effect of sampling timing on PMNan

## **Critical Values**

Variable	Pre-plant vs. V5 sampling timing
Larger Values: Pre-plant > V5 <u>and</u> Smaller Values: V5 > Pre-plant	
C:N	9.7:1
Larger Values: V5 > Pre-plant <u>and</u> Smaller Values: Pre-plant > V5	
Sum of precipitation	0.4 in.
SDI Evenness of	0.63
AWDR rainfall	115
Growing degree-days	359
V5 soil NO <sub>3</sub> -N (0-12 in; 0-N)	8.2 ppm

## Nitrogen addition can influence PMNan at V5

🗖 0-N 📕 160-N

![](_page_26_Figure_2.jpeg)

# PMNan from 160N > 0N under greater organic matter

![](_page_27_Figure_1.jpeg)

# Soil conditions influence effect of N addition on PMNan

## **Critical Values**

Variable	Pre-plant vs. V5 sampling timing
Larger Values: 0-N > 160-N <u>and</u> Smaller Values: 160-N > 0-N	
Clay	10 %
V5 soil NO <sub>3</sub> -N (0-12 in; 0-N)	2.03 ppm
Larger Values: 160-N > 0-N <u>and</u> Smaller Values: 0-N > 160-N	
Total organic carbon	2.1 %
Organic matter	3.8 %
C:N	11.02

Q-1) Does incubation length, soil sampling timing, and N fertilization influence PMNan?

- PMNan increases with incubation length
- Soil sampling timing of 0-N areas can influence PMNan
- N fertilizer has no impact or decreases PMNan at V5 sampling

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![](_page_31_Figure_0.jpeg)

# Pre-plant N mineralization does not predict EONR well

![](_page_32_Figure_1.jpeg)

# V5 N mineralization <u>WITHOUT N</u> does not predict EONR well

![](_page_33_Figure_1.jpeg)

# V5 N mineralization <u>WITH N</u> does not predict EONR well

![](_page_34_Figure_1.jpeg)

#### Delayed sampling and increased incubation length do not improve predictability of EONR

![](_page_35_Figure_1.jpeg)

## **PMNan in Minnesota vs. EONR**

![](_page_36_Figure_1.jpeg)

Q-2) Will changes in PMNan due to sampling timing, N rate, and incubation length improve predictability of EONR?

## No increase in the predictability of EONR by:

- Increasing incubation length
- Delaying soil sampling
- N fertilizer addition

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# Predicting grain yield at 0-N, grain yield at EONR, and EONR with:

- Soil nitrate (PPNT and PSNT)
- Soil nitrate + mineralizable nitrogen (PMNan)
- Soil nitrate + PMNan + initial NH<sub>4</sub>+

### PPNT is not well related to grain yield at 0-N.

![](_page_40_Figure_1.jpeg)

#### **PSNT improves relationship with** grain yield at 0-N. PPNT: R<sup>2</sup> = 0.18

![](_page_41_Figure_1.jpeg)

### Including soil NO<sub>3</sub><sup>-</sup>, PMNan, and NH<sub>4</sub><sup>+</sup> improves predictability of grain yield at 0-N.

![](_page_42_Figure_1.jpeg)

# Soil textures varied across the 49 site-years

![](_page_43_Figure_1.jpeg)

# Mean annual temperature increases from 35 to 65°F

![](_page_44_Figure_1.jpeg)

## Predictability of <u>grain yield at 0-N</u> improved by texture or temperature categories with PMNan used varying

![](_page_45_Figure_1.jpeg)

#### Adding N lowers the ability to predict grain yield.

![](_page_46_Figure_1.jpeg)

![](_page_46_Figure_2.jpeg)

Soil N Sampling Timing

### Predictability of <u>grain yield at EONR</u> improved by texture or temperature categories with PMNan used varying

#### **Grain Yield at EONR**

![](_page_47_Figure_2.jpeg)

# Adding N lowers predictability of <u>EONR</u>

![](_page_48_Figure_1.jpeg)

## Predictability of <u>EONR</u> improved by texture or temperature categories with PMNan used varying

![](_page_49_Figure_1.jpeg)

Q-3) Can using PMNan values in conjunction with other soil-N tests improve corn response predictions?

# Grain yield and EONR predictability increased by:

- Delaying soil-N sampling from PPNT to PSNT
- Separating by soil texture and temperature
  - $\bullet$  Including PMNan and initial  $\rm NH_4^+$ 
    - PMNan used varies by texture or temperature categories

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# Predicting relative grain yield with:

- PPNT
- PSNT
  - Inclusion of mineralizable nitrogen (PMNan)

## PPNT alone did not predict relative yield well

![](_page_53_Figure_1.jpeg)

#### PPNT + PMNan did not predict relative yield well

![](_page_54_Figure_1.jpeg)

### **PSNT predicted relative yield well**

![](_page_55_Figure_1.jpeg)

### **PSNT + PMNan increased over-application rate**

![](_page_56_Figure_1.jpeg)

Q-4) Can including PMNan with soil-N tests improve N sufficiency indexes?

> Including PMNan lowered predictability of relative yield and increased overapplication rates of N

# Conclusions

- PMNan is influenced by incubation length, soil sampling timing, and N fertilizer addition
- Predictability of grain yield and EONR was low but it was improved by:
  - Delaying soil-N sampling from PPNT to PSNT
  - Including PMNan and initial NH<sub>4</sub><sup>+</sup> with PPNT or PSNT
  - Separating by texture or temperature
- Inclusion of PMNan with soil-N tests did not improve N sufficiency indexes

# Future research

# Further improve grain yield and EONR predictability by:

 Including other soil and weather conditions with PMNan and soil-N tests

# Acknowledgements

![](_page_60_Picture_1.jpeg)

![](_page_61_Picture_0.jpeg)

North Dakota St. University

Fabián Fernández

John Sawyer

![](_page_61_Picture_4.jpeg)

Carrie Laboski University of Wisconsin

Richard Ferguson **N** University of Nebraska

![](_page_61_Picture_7.jpeg)

![](_page_61_Picture_8.jpeg)

![](_page_61_Picture_9.jpeg)

Emerson Nafziger University of Illinois

![](_page_61_Picture_11.jpeg)

![](_page_61_Picture_12.jpeg)

James Camberato Purdue University

# **Thank You!**

![](_page_62_Picture_1.jpeg)

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