Development of a New Procedure to Design In-season Variable Rate Nitrogen (N) Fertilizer Prescription Maps for Michigan Wheat Farmers

Year 1 Summary

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Rationale

- Precision agricultural technologies are useful tools to apply fertilizer more efficiently for Michigan wheat

- Current N prescription services are costly, complicated, and sometimes incorrect

- Increasing N use efficiency in wheat will make farmers more productive and profitable
2019 Yield Map
Objectives

1. Synthesis of historical field observations and image analysis
Objectives

2. Crop simulation modeling using up-to-date weather forecasts
Objectives

3. In-season variable rate N application

Remotely Sensed Imagery

Total N As Applied

Wrong tips & rate caused additional 55 lb N/ac applied
Historical Yield Monitor Data

2006 Corn

Yield
- < 100
- 100 to 140
- 140 to 150
- 150 to 160
- 160 to 170
- 170 to 180
- 180 to 190
- 190 to 200
- 200 to 210
- 210 to 220
- 220 +
Yield Stability Map

Total area: 85 acres
13 years of yield data

Stability Zones
- Low & Stable
- Medium & Stable
- High & Stable
- Unstable Depression
- Unstable Hilltop
Applied From Rx

Total area: 85 acres

13 years of yield

Wrong tips & rate caused additional 55 lb N/ac applied
2019 Yields by Yield Stability Zone

Yield (bu/ac)

Total N (lb/ac)

102.2
116.0
129.9
143.7
185.3

Stability Zone
- High & Stable
- Medium & Stable
- Low & Stable
- Unstable

High N Reference Strips
2019 NUE by Yield Stability Zone

Nitrogen Use Efficiency

Total N (lb/ac)

Stability Zone
- High & Stable
- Medium & Stable
- Low & Stable
- Unstable

High N Reference Strips

NUE < 1.0
Additional Field with High Reference N Strips

- Variable rate applied in 3 different applications
- High total N in Reference Strips was 204 lb N/ac
- High total N in Rx was 117 lb N/ac
- How can we maximize yield with intensive management?
2019 Yields by Yield Stability Zone

**Basso Rx**

- Total N (lb/ac): 77, 87, 97, 107, 117
- Yield (bu/ac):
  - 77: Stable
  - 87: Stable
  - 97: Stable
  - 107: Stable
  - 117: Stable

**High N Reference Strips**

- Total N (lb/ac): 114, 174, 204
- Yield (bu/ac):
  - 114: Stable
  - 174: Stable
  - 204: Stable

Legend:
- Blue: High & Stable
- Green: Medium & Stable
- Yellow: Low & Stable
- Red: Unstable
2019 NUE by Yield Stability Zone

NUE < 1.0

Stability Zone
- High & Stable
- Medium & Stable
- Low & Stable
- Unstable

Basso Rx

High N Reference Strips

Total N (lb/ac)

77 87 97 107 117

114 174 204

Nitrogen Use Efficiency

NUE < 1.0
Data Layers Included

- Bare Soil
- Topography
- Soil Maps
- Topographic Wetness Index
In-Season Crop Modeling

40 yrs Wx x 5 YSZs x 10 N scenarios x 10 soils = 20,000 outputs!
Management Information

- Planted September 27\textsuperscript{th} & 28\textsuperscript{th} (Drilled)
- Granular 60 lb N/ac applied with clover on April 3\textsuperscript{rd}
- Liquid 19.7 lb N/ac applied with a fungicide on May 14\textsuperscript{th}
- Variable Rate applied on May 31\textsuperscript{st}

<table>
<thead>
<tr>
<th>Varied Rates</th>
<th>At planting (lb N/ac)</th>
<th>Top-dress 1 (lb N/ac)</th>
<th>Top-dress 2 (lb N/ac)</th>
<th>Top-dress 3 (lb N/ac)</th>
<th>Total N (lb N/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>22.5</td>
<td>60.0</td>
<td>19.7</td>
<td>0.0</td>
<td>102.2</td>
</tr>
<tr>
<td>Medium</td>
<td>22.5</td>
<td>60.0</td>
<td>19.7</td>
<td>13.8</td>
<td>116.0</td>
</tr>
<tr>
<td>High</td>
<td>22.5</td>
<td>60.0</td>
<td>19.7</td>
<td>27.7</td>
<td>129.9</td>
</tr>
</tbody>
</table>
Rx Creation

1. RGB on May 23

2. Classified RGB on May 23

3. Assigned classes to a grid using the majority class value

4. Assigned rates and adjusted areas without wheat
Rx Map (Applied May 31)
Total N Applied

Inherent field scale variability with the interaction of weather, wheat variety, management, and soil are the causes of these yield differences year after year...
Take Home Messages

• **Technology** is not the **solution, technology** is only a **tool**.

• Using yield history, remotely sensed imagery, and crop simulation modeling offers a more complete picture of plant health related to N or other stresses.
Additional Considerations

• How do growth regulators assist in N uptake at different yield stability zones?

• How early can we vary N at the field-scale without losing potential yield in areas that might improve?

• How scalable is field-based research unless a system based approach is implemented?
Many thanks to Michigan Wheat for their support!