Genetic Changes and Nutrient/Water Stress Interaction Consequences for NUE Improvement in Rainfed Corn

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Corn Hybrid Era Gains in Yield and in Recovery of Late-Season N Applications?

<table>
<thead>
<tr>
<th>N Treatment Name</th>
<th>kg N ha⁻¹ @ V3-V4</th>
<th>kg N ha⁻¹ @ R1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0_0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>200_0</td>
<td>220</td>
<td>0</td>
</tr>
<tr>
<td>150_50</td>
<td>150</td>
<td>50</td>
</tr>
</tbody>
</table>

Hybrids (1946-2015)

1. 352HYB (1946)
2. 354A (1958)
3. 3390 (1967)
4. 3382 (1976)
5. 3335 (1995)
6. 34N42 (2003)

Source: Mueller et al., 2019, Scientific Reports
Pioneer Era Hybrid - Grain Yield Response to N Timing

Modern hybrids produce more yield per unit N applied.

Source: Mueller et al., 2019, Scientific Reports
Grain Yield Response to N Rate with Pioneer Era Hybrids (average of 2016-2017)

\[ y = 0.7589x - 1404.9 \]
\[ R^2 = 0.9623 \]

\[ y = 2.0359x - 3840.3 \]
\[ R^2 = 0.9706 \]

Source: Mueller et al., 2019
Nitrogen Fertilizer Recovery Efficiency (NRE) Matters!

$$\text{NRE (\%)} = \frac{\text{Total N uptake at any N rate (lb/acre)} - \text{Total N Uptake at Zero N (lb/acre)}}{\text{Actual N RATE APPLIED (lb/acre)}} \times 100$$

Photo credit: Mike Shuter

2015 Hybrid

1958 Hybrid
Nitrogen Use Efficiency Changes over Time

Source: Mueller et al., 2019, Scientific Reports
Kernel Number and Kernel Weight Gains in Pioneer “Era” hybrids with year of commercial release (West Lafayette, 2016-2017)

Source: Mueller and Vyn, unpublished, 2018
Nitrogen Recovery Efficiency with Pioneer Era Hybrids (Two N timing treatments; 2016-2017)
Corn Side-dress N Placement Experiment 2017-19

July 17

July 25

September 8
Late-Split UAN applied at V12 by Y-Drops (2015-2019)
Kernel Weight Gain during Grain Fill as Affected by N Rate/Timing

84 bu/ac
15 pounds N/acre

241 bu/ac
200 pounds N/acre,
All applied at planting

254 bu/ac
200 pounds N/acre,
150 at planting, 50 at V12

Kernel Weight Gain during Grain Fill as Affected by N Rate/Timing

Days from silking to dry weight gain plateau in kernels

Peak at: 51 days 55 days 56 days
Kernel #/m²: 2500 4600 4500
Corn NRE Response to Tillage Systems Following Soybean (2015-2018)

Source: Omonode and Vyn, unpublished
Rainfall Timing and Consequences for NRE

Source: Omonode and Vyn, JEQ, 2019
# Global Maize: Selected Summary Results for Corn (2012-2018)

<table>
<thead>
<tr>
<th>Plant Density/Nutrient Management System Treatment</th>
<th>Time to 50% silk emergence (days)</th>
<th>R1 Earleaf N (%)</th>
<th>R1 Earleaf K (%)</th>
<th>Grain Yield (bu/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP- 31,000 ppa, Zero N</td>
<td>80.9 b</td>
<td>1.73 d</td>
<td>1.69 c</td>
<td>105 e</td>
</tr>
<tr>
<td>FP- 31,000 ppa, 100 N</td>
<td>79.1 de</td>
<td>2.61 c</td>
<td>1.80 b</td>
<td>188 d</td>
</tr>
<tr>
<td>FP- 31,000 ppa, 160 N</td>
<td>78.7 e</td>
<td>2.75 b</td>
<td>1.81 b</td>
<td>208 c</td>
</tr>
<tr>
<td>EI- 38,000 ppa, Zero N (plus Aspire, Instinct, and AMS)</td>
<td>82.3 a</td>
<td>1.69 d</td>
<td>1.82 b</td>
<td>101 f</td>
</tr>
<tr>
<td>EI- 38,000 ppa, 160 N (plus Aspire, Instinct, and AMS)</td>
<td>79.6 cd</td>
<td>2.78 b</td>
<td>1.92 a</td>
<td>217 b</td>
</tr>
<tr>
<td>EI- 38,000 ppa, 160 + 60 N (plus Aspire, Instinct, and AMS)</td>
<td>79.8 c</td>
<td>2.91 a</td>
<td>1.92 a</td>
<td>225 a</td>
</tr>
</tbody>
</table>

*Source: Vyn, West and Omonde (unpublished)*

Nitrogen Use Efficiency (kg kg\(^{-1}\))

Nitrogen Recovery Efficiency (%)

Daily \(\text{N}_2\text{O} \) (g N ha\(^{-1}\) d\(^{-1}\))

\[ Y = 4.03 - 0.024x \]
\[ R^2 = 0.23; P = 0.017 \]

N = 24
Summary of Some Controlling Factors in “NUE Improvement”

- Rainfall amount and timing after N application.
- N rate and timing relative to corn N uptake. Amount of prior N applied relative to corn N demand before the most recent N applied becomes available is critical.
- N source (inhibitors added?) and adequacy of other nutrients (e.g. K).
- Genetics and Plant Density (and consequences for kernel number/weight and kernel N)
- Extent of post-silking N uptake for that hybrid and environment.
- Tillage and Rotation System
Acknowledgments
Thank You