Nitrogen Source and Rate Effects on Corn Yield and Economics in the Western Corn Belt
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Background

• Nitrogen (N) plays an essential part in developing life on earth. It is used as a major building block in different organic components.
• Although N is critical for the life development in the world, it can also cause problems in the environment.
• Environmental concerns include an excess amount of N that could be released into the atmosphere and the groundwater.
• N can be released in the atmosphere as $N_2O$ which is one of the greenhouse gases responsible for climate change.
• N can also be leached from the soil ($NO_3^-$) and contaminate surface and groundwater.
• A balance between corn yield, minimizing environmental risks, and economic profit for producers are required for a sustainable system.

Hypotheses

• Synthetic N fertilizer (urea ammonia nitrate, UAN) would produce a higher crop yield than manure fertilizer.
• A higher amount of N fertilizer (200 kg ha⁻¹) available in the soil would produce a higher crop yield than soils with smaller amounts of N fertilizer (125 kg ha⁻¹).
• A larger rate of manure treatment would give the farmer a larger profit.

Materials and Methods

• The South Central Agricultural Laboratory (SCAL) experimental study was established in 2010. (Clay Center, NE)
• Soil type at the SCAL study site is a Hastings silt loam (Mesic, Udic Argiustoll).
• The experiment is a continuous corn system that consists of four randomized replicates of manure and synthetic N fertilizer plots (125 kg N ha⁻¹ and 200 kg N ha⁻¹ amounts) under full irrigation.
• SCAL was a furrow-irrigated, ridge-till corn-soybean rotation system prior to study and was last disked in April 2010.
• Data presented is from 2011 to 2017.
• Data was analyzed using SAS 9.3 where anything less than or equal to 0.05 was considered significant.
• Price of corn was $5.00/bu. ($0.197/kg)
• UAN price was $331/ton*1ton/907kg = (X*$0.36/kg) + $37.73
• Manure was $35/ton*1ton/907kg = (M*$0.04/kg) + $58.05

Results and Discussion

• There was a significant difference in grain yield between the two N rates (Table 2).
• Grain yield was similar by N source ($P = 0.8414$) and the interaction between N source and N rate ($P = 0.8880$).

Table 2. Analysis of variance results of corn yield on N rate (125 or 200 kg ha⁻¹) and N source (manure or UAN).

<table>
<thead>
<tr>
<th>Effect</th>
<th>Den DF</th>
<th>Significance (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N rate</td>
<td>108</td>
<td>0.0002</td>
</tr>
<tr>
<td>N source</td>
<td>108</td>
<td>0.8414</td>
</tr>
<tr>
<td>N rate x N source</td>
<td>108</td>
<td>0.8880</td>
</tr>
</tbody>
</table>

Table 1. Summary of Treatments Observed at SCAL.
Manure applications were applied in even years.

<table>
<thead>
<tr>
<th>N treatment</th>
<th>N Rate (kg ha⁻¹)</th>
<th>N source (kg ha⁻¹)</th>
<th>Placement</th>
<th>Application time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure</td>
<td>125</td>
<td>55 + 70 UAN</td>
<td>Surface</td>
<td>Fall</td>
</tr>
<tr>
<td>Manure</td>
<td>200</td>
<td>57 + 143 UAN</td>
<td>Surface</td>
<td>Fall</td>
</tr>
<tr>
<td>UAN</td>
<td>125</td>
<td>125 UAN</td>
<td>Knifed</td>
<td>Side-dress</td>
</tr>
<tr>
<td>UAN</td>
<td>200</td>
<td>200 UAN</td>
<td>Knifed</td>
<td>Side-dress</td>
</tr>
</tbody>
</table>

Figure 1. SCAL Map Location.
1a. Top left: Arial image of the SCAL field.
1b. Center: Tractor spreading manure on plots.
1c. Top Right: Corn plants on treatment plots observed at SCAL.

Figure 2. Grain yield averages of Manure (M) and UAN (X) under two N rates (1 = 125 kg ha⁻¹; 2 = 200 kg ha⁻¹).

Figure 3. Profits of the four treatments subtracting expenses from revenue.

Figure 4. Total expenses from the four treatments.

Conclusion

The data provided supports the following conclusion:
• Manure treated fields produced a slightly higher corn yield when compared to Synthetic N, but there is no significance in the different sources.
• The 200 kg ha⁻¹ N rates produced higher corn yield than the 125 kg ha⁻¹ rate.
• The N treatment at 200 kg ha⁻¹ received a larger rate of manure gave the largest profit to the farmer.

Acknowledgements

I would like to thank Dr. Marty Schmer for choosing me to be part of the APS internship program and being my mentor.
I also thank Grant Program no. 2017-67032-26018 from the USDA National Institute of Food and Agriculture.