Use of Nitrification Inhibitor with Manure

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Industrial fixation

\[ \text{NO} \rightarrow \text{NO}_2 \rightarrow \text{NO}_3^- \]

Removed from cycle by harvesting

Atmospheric \( N_2 \)

Symbiotic fixation (legumes)

Nitrogen fertilizer

Volatileization \( \text{NH}_3 \)

\[ \text{NH}_4^+ \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^- \]

Controlled by:
- Supply of \( \text{NH}_4 \)
- Temp. & moisture
- Population of nitrifying organisms
- Soil pH
- Oxygen is required

\[ \text{NH}_4^+ + \text{O}_2 \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^- \]

Inhibitors temporarily block
Effect of Instinct and time of broadcast/incorporated dairy slurry application on corn yield and total N uptake at Arlington, WI, 2011

<table>
<thead>
<tr>
<th>Timing</th>
<th>Instinct</th>
<th>Mean Timing</th>
<th>Instinct</th>
<th>Mean Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Grain Yield, bu/a</td>
<td>Silage Yield, T DM/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall 10/21; 52 lb avail. N/a</td>
<td>135</td>
<td>141</td>
<td>138</td>
<td>7.25</td>
</tr>
<tr>
<td>Spring 5/3; 67 lb avail. N/a</td>
<td>135</td>
<td>156</td>
<td>146</td>
<td>7.15</td>
</tr>
<tr>
<td>Mean Instinct</td>
<td>135</td>
<td>149</td>
<td>146</td>
<td>7.20 b</td>
</tr>
</tbody>
</table>

**Instinct**
- Did not effect soil NO$_3$ or NH$_4$ concentrations in late fall, spring (0-2’), or PSNT.
- Significantly increased V8 & VT SPAD meter readings for both application timings
N availability from digested, separated dairy liquid manure as affected by application timing and use of Instinct

- 8 site-years
  - All sites well drained, except Waterloo 2012 (poorly drained)

- Timing
  - Early fall – early/mid-Oct.
  - Late fall – early/mid- Nov.
  - Spring

- 8,700 gal/a; ~55-60% NH₄⁻N

- With and without Instinct
  - Label rates (37 vs 70 oz/a)
  - Added to tanker & agitated

- Injected application
Effect of Instinct & manure timing on 0-2’ soil N at ~V6

* Indicate significant differences with Instinct application for a given location/year/timing
Effect of Instinct & manure timing on grain yield

- *Indicate significant differences with & without Instinct application for a given location/year/timing*
Effect of Instinct & manure timing on silage yield

* Indicate significant differences with & without Instinct application for a given location/year/timing
Fertilizer N equivalence value of manure

- Liquid + Instinct, no sidedress N yielded 169 bu/a
- NFEV = 16 lb N/a
- Agronomic Opt N Rate = 146 lb N/a
- Yield = 215 bu/a
Manure N availability as influenced by timing of application and use of Instinct

<table>
<thead>
<tr>
<th>Year</th>
<th>Timing</th>
<th>Arlington</th>
<th>Sun Prairie</th>
<th>Waterloo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Instinct</td>
<td>+ Instinct</td>
<td>- Instinct</td>
<td>+ Instinct</td>
</tr>
<tr>
<td>2013</td>
<td>Early Fall</td>
<td>39</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Late Fall</td>
<td>45</td>
<td>55</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>70</td>
<td>63</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>2014</td>
<td>Early Fall</td>
<td>-</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Late Fall</td>
<td>44</td>
<td>63</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Availability calculated using N fertilizer equivalence value method

* Availability could not be calculated with this method.
- Indicates treatment did not exist.
Summary

• Lost sites because of drought: A12, SP12
• In general, regardless of time of manure application, use of Instinct with liquid dairy manure on well drained soils did not have much an effect on:
  – Late fall soil NO$_3$ & NH$_4$ concentrations in the 0-4’ profile
  – Soil NO$_3$ & NH$_4$ concentrations in the 0-2’ profile at V6
  – Grain & silage yield

• Calculated manure N availability suggests Instinct may have been effective at improving N availability for some sites/timings
Evaluation of the use of Instinct with spring manure application in sandy soils

• Locations
  – Coloma (Billet sandy loam)
  – Grand Marsh (Billet sandy loam & Richford loamy sand)

• Main plot treatments
  – No manure
  – Separated-liquid, injected
    • 413 & 429 lb total N/a
  – Separated-liquid + 34 oz Instinct, injected
    • 427 & 443 total lb N/a
  – Separated solid (131 & 138 lb N/a)

58% NH₄
Instinct reduced $\text{NO}_3^-$-N leaching where separated-liquid was applied at Coloma, but not Grand Marsh

- Grand Marsh had higher pH than Coloma (6.6 vs. 6.2, respectively), which may have increased nitrapyrin degradation
- Grand Marsh had greater OM than Coloma (1.6% vs. 1.2%, respectively)
- Irrigation at Grand Marsh started earlier and was 13” for the season compared to 12” for Coloma
Effect of fall swine manure application timing and use of Instinct on corn grain yield in Minnesota

• Treatments
  – Two manure application timings: Early October (immediately after soybean harvest and early November (soil temps < 50° F).
    • Manure rate based on manure nutrient analysis from each application timing to give 120 lb of available N/ac based on 80% availability if sweep injected.
  – Three rates of Instinct (0, 35, and 70 oz./ac)

• Experimental sites: at SROC in Waseca, MN
  – Nicollet-Webster clay loam soils:
    • SOM=4.5-5-5%
    • Somewhat poorly & poorly drained soil

• Previous crop: soybean

Vetsch, 2015
Soil NO₃-N and NH₄-N (0-1 ft) as affected by swine manure application timing and Instinct™ rate

Nitrate-N and ammonium-N, ppm

Vetsch, 2015. unpublished
Corn grain yield as affected by swine manure application timing and Instinct™ rate.

<table>
<thead>
<tr>
<th>Application Timing</th>
<th>Instinct Rate (oz./acre)</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>4-Yr Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 0</td>
<td>171</td>
<td>175</td>
<td>165b</td>
<td>138</td>
<td></td>
<td>162b</td>
</tr>
<tr>
<td>October 35</td>
<td>180</td>
<td>170</td>
<td>185a</td>
<td>161</td>
<td></td>
<td>174a</td>
</tr>
<tr>
<td>October 70</td>
<td>185</td>
<td>179</td>
<td>190a</td>
<td>161</td>
<td></td>
<td>179a</td>
</tr>
<tr>
<td>November 0</td>
<td>182</td>
<td>188</td>
<td>192a</td>
<td>145</td>
<td></td>
<td>177a</td>
</tr>
<tr>
<td>November 35</td>
<td>194</td>
<td>181</td>
<td>186a</td>
<td>158</td>
<td></td>
<td>180a</td>
</tr>
<tr>
<td>November 70</td>
<td>194</td>
<td>184</td>
<td>193a</td>
<td>153</td>
<td></td>
<td>181a</td>
</tr>
</tbody>
</table>

Effect of Application Timing
- October: 179b, 175a, 180b, 153a, 172b
- November: 190a, 184a, 190a, 152a, 179a

Effect of Instinct Rate
- 0 oz/ac: 177b, 182a, 178b, 142b, 170b
- 35 oz/ac: 187a, 176a, 185ab, 159a, 177a
- 70 oz/ac: 189a, 182a, 191a, 157a, 180a

Interaction Effects
- Timing×Rate: NS, NS, **, NS, *

Vetsch, 2015. unpublished
Effect of soil temperature on nitrification of \((\text{NH}_4\text{)}_2\text{SO}_4\) applied to a Canadian soil with \(~3.4\%\) organic matter

![Graph showing the effect of soil temperature on nitrification of ammonium sulfate.](image)

Redrawn from Chandra, 1962.
Relative probability of increasing corn yield using a nitrification inhibitor

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Time of nitrogen application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
</tr>
<tr>
<td>Sands &amp; loamy sands</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Sandy loams &amp; loams</td>
<td>Fair</td>
</tr>
<tr>
<td>Silt loams &amp; clay loams</td>
<td>Fair</td>
</tr>
<tr>
<td>Well drained</td>
<td>Fair</td>
</tr>
<tr>
<td>Somewhat poorly drained</td>
<td>Good</td>
</tr>
<tr>
<td>Poorly drained</td>
<td>Good</td>
</tr>
</tbody>
</table>

Note: Table was developed based on data collected in Wisconsin and the upper Midwest.
Thank you!

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