Nitrogen Source and Placement Effects on Nitrous Oxide Emissions from Irrigated Strip-Till and No-Till Corn Production Systems

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Background Information:

- Agriculture contributes ~67% of U.S. total N$_2$O emissions, with application of N fertilizers to croplands contributing a significant portion of this amount.

- Global Warming Potential of N$_2$O is ~296 times greater than CO$_2$.

- Application N fertilizer generally increases N$_2$O emissions from cropping systems.

- Therefore, it is important that we develop management practices to reduce N$_2$O emissions from agricultural cropping systems.
Review of N Source Research Completed in 2010

Strip-Till Corn, 2 Year Average (2009 & 2010)

N$_2$O-N loss per unit of N applied was:
- 0.8% Urea
- 0.5% ESNssb
- 0.4% ESN
- 0.3% SuperU
- 0.4% UAN
- 0.3% UAN+Nf
- 0.2% UAN+AP

Published: Halvorson et al., 2011, JEQ 40:1775-1786
Average Cumulative Growing Season Soil $\text{N}_2\text{O}-\text{N}$ Flux in Irrigated No-Till Continuous Corn for 2009 and 2010

Manuscript: In rough draft form. Will be submitted to JEQ

$\text{N}_2\text{O}-\text{N}$ loss per unit of N applied:
- 0.7% Urea
- 0.6% ESNssb
- 0.4% UAN
- 0.3% ESN
- 0.3% SuperU
- 0.2% UAN+AP

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Growing Season Cumulative N\textsubscript{2}O FLux (6 May - 29 Sept.)
Average of Strip-Till and No-Till systems (2009-2010)

Averaged across Strip-Till and No-Till

N Source

- Urea
- ESNssb
- UAN
- SuperU
- ESN
- UAN+AP
- Check

Cumulative N\textsubscript{2}O-N Flux (g N ha\textsuperscript{-1})

0
200
400
600
800
1000
1200
1400
1600
1800

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N Source Effects on Reducing $\text{N}_2\text{O}$-N Emissions Compared to Urea and UAN, Averaged Across Strip-Till and No-Till corn (4 site years)

- Compared to Urea
  - ESNssb (23%)
  - UAN (42%)
  - SuperU (50%)
  - ESN (53%)
  - UAN+AgrotainPlus (66%)

- Compared to UAN
  - SuperU (14%)
  - ESN (19%)
  - UAN + AgrotainPlus (43%)

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Averaged across Strip-Till and No-Till

Average \( N_2O-N \) loss/unit \( N \) applied
(ST and NT, 2009-2010)

<table>
<thead>
<tr>
<th>N Source</th>
<th>Average ( N_2O-N ) loss per unit ( N ) applied (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>0.8</td>
</tr>
<tr>
<td>ESNssb</td>
<td>0.6</td>
</tr>
<tr>
<td>UAN</td>
<td>0.4</td>
</tr>
<tr>
<td>SuperU</td>
<td>0.3</td>
</tr>
<tr>
<td>ESN</td>
<td>0.2</td>
</tr>
<tr>
<td>UAN+AP</td>
<td>0.1</td>
</tr>
</tbody>
</table>

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No Tillage x N Source Interaction
2011 Study Objective and Treatments:

- **Study Objective:** Evaluate effects of N fertilizer source and placement (surface broadcast and band) on growing season N$_2$O emissions under ST and NT, irrigated continuous corn production.

- **N Fertilizer Sources compared:**
  - dry granular urea (46-0-0)
  - polymer-coated urea (ESN, 44-0-0)
  - stabilized urea (SuperU, 46-0-0)
  - liquid UAN (32% N) (Strip-Till only)
N Management Details

- **N Rate:**
  - 202 kg N/ha all N sources

- **N Placement:**
  - surface broadcast or band applied at corn emergence
  - 19 mm (0.75”) irrigation water applied next day

- **Designation of N Treatments:**
  - ESN: ESN bd = band; ESN bc = broadcast
  - SuperU: SUbd = band; SuperU: SUbc = broadcast
  - Urea: U bd = band; U bc = broadcast
  - UAN: UAN bd = band; UAN bc = broadcast (Strip-Till only)
Greenhouse Gas Measurements

- Randomized complete block design with 3 replications and 2 GHG measurements per rep (total 6 GHG measurements/treatment) per tillage treatment.

- $\text{N}_2\text{O}$ measurements: 2 to 3 times per week, immediately following crop planting until crop harvest (growing season).

- Static, vented chamber technique was used to collect the gas samples in the field.

- Gas chromatograph used to determine $\text{N}_2\text{O}$ concentration in gas sample.
ARS Technicians collecting GHG samples, soil temp, and water data in ST-CC rotation.

Injecting field gas samples into vials for analysis on Varian 3800 GC.
Cumulative Soil N$_2$O-N Flux During Growing Season in Irrigated Strip-Till Continuous Corn

2011 Strip-Till continuous corn (6 May-1 Nov.)

Cumulative N$_2$O flux (g N ha$^{-1}$)

(N applied 25 May 2011; DOY 145)

- Check
- Ubc
- Ubd
- SUbc
- SUbd
- ESNbc
- ESNbd
- UANbc
- UANbd

DOY

121 151 181 211 241 271 301 331

Check (no N applied)
### Growing Season Cumulative Soil N\textsubscript{2}O-N Flux Under Irrigated Strip-Till Continuous Corn

#### 2011 Growing season N\textsubscript{2}O emissions in Strip-Till corn

<table>
<thead>
<tr>
<th>N Source</th>
<th>Placement</th>
<th>Cumulative N\textsubscript{2}O-N flux (g N ha\textsuperscript{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>Band</td>
<td>A</td>
</tr>
<tr>
<td>ESN</td>
<td>Band</td>
<td>B</td>
</tr>
<tr>
<td>UAN</td>
<td>Band</td>
<td>B</td>
</tr>
<tr>
<td>SuperU</td>
<td>Band</td>
<td>C</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>A</td>
</tr>
<tr>
<td>Band</td>
<td>Band</td>
<td>A</td>
</tr>
<tr>
<td>Broadcast</td>
<td>Band</td>
<td>B</td>
</tr>
</tbody>
</table>

- A: 26% < urea
- B: 31% < urea
- C: 51% < urea
- Band: 20% < band

No N source x N placement interaction

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Cumulative Soil N$_2$O-N Flux During Growing Season in Irrigated No-Till Continuous Corn

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Growing Season Cumulative Soil N\textsubscript{2}O-N Flux Under Irrigated No-Till Continuous Corn

2011 Growing season N\textsubscript{2}O emissions in No-Till corn

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N$_2$O Emissions averaged over Tillage system in 2011

Cumulative G.S. N$_2$O flux (g N ha$^{-1}$)

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No N source x N placement interaction.
N Source and Placement Effects on Grain Yield
Average Over Strip-Till and No-Till

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N Source and Placement Effects on Grain N Uptake Averaged across Strip-Till and No-Till

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ESN, SuperU, UAN+AgrotainPlus, and UAN significantly reduced $N_2O$ emissions when compared to urea; and ESN and UAN+AP compared to UAN.

Growing season $N_2O$-N losses per unit of N applied were generally < 0.8% for urea, <0.6% for ESNssb, and <0.4% for all other sources.

Broadcast placement reduced $N_2O$ emissions compared to band placement in both tillage systems in 2011.

Corn grain yields or N uptake generally did not differ among N sources or with N placement.

N source selection is a management option for reducing $N_2O$ emissions in semi-arid, irrigated cropping systems.
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Thanks for Listening!!

Questions???