Manure Opportunities In Forages and Cereals

Environmental Sustainability Research Forum
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Ball-Coelho, Murray, Bruin, Brown and Johnson – AAFC/OMAFRA
Why Apply Manure to Wheat or Forages?

- Apply P and K that crop has removed
- Save commercial fertilizer dollars
- Reduce manure storage requirements
- Reduce spring compaction damage
- Spread out workload
- Reduce environmental losses
  - GHG emissions /leaching
- Can we increase yield?
- Can we increase quality?
Research Questions

**Wheat**
- Understand manure N movement and soil inorganic N dynamics
- Quantify manure N credit to winter wheat
- Impact of fall applied manure on winter kill, and disease

**Forages**
- Can manure applied to living crops reduce greenhouse gas emissions and/or leaching?
- Impact of weather at application on N volatilization loss.
- Effect of manure on alfalfa and alfalfa/grass mixtures:
  - forage yield
  - forage quality
  - stand composition
  - change in species composition over time
Research Scale v.s. Field Scale

Research Scale
- More options can be compared
- Easier to control extraneous variables
- Small scale can minimize variability
- Replications can minimize variability
- Ease of sampling

Field Scale
- Practical application – typical farm logistics
- Economic implications on-farm
- Looking at responses across typical variability
- Neighbourhood extension opportunity
Manure on Wheat - Research Scale

Two research-scale experiments - fall 2008, 2009, & 2010 (loam and clay loam)
The 4 sites had 10 m x 6 m plots - 3 or 4 randomized block design replications

May 7 2010 London
Example of Results:
Concentration and uptake of N in grain and straw and at harvest, 2010
Manure on Wheat - Fall 2010 Research Scale

1) broadcast full rate
2) ½ rate injected
3) full rate injected
4) full rate injected + Biochar
5) full rate injected + ATS (ammonium thiosulfate) (1:417 v/v)
   12 Oct at London and 13 Oct. at Aylmer
   6 x 10 m plots in randomized blocks with four replications

“We learned that when adding biochar to manure in a tank applicator, for ease of mixing it is best to partially fill the tank with manure, then add the biochar and then the rest of the manure because the biochar floats and is somewhat water repellent, so is difficult to mix if added on top. This property would make the biochar a practical option for odour reduction from lagoons.”

Ball-Coelho
## Field Scale Summary

### 2009 / 2010 Yield Summary – Manure on Wheat

<table>
<thead>
<tr>
<th></th>
<th>Full Fert</th>
<th>Full Manure</th>
<th>2/3 manure + 1/3 Fertilizer</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg 12 sites</td>
<td>80.5</td>
<td>76.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg 11 sites</td>
<td>81.2</td>
<td>76.9</td>
<td>80.4</td>
<td></td>
</tr>
<tr>
<td>Avg 10 sites</td>
<td>81.8</td>
<td>76.4</td>
<td>81.4</td>
<td>52.4</td>
</tr>
</tbody>
</table>

### 2009 / 2010 Protein Summary

<table>
<thead>
<tr>
<th></th>
<th>Full Fert</th>
<th>Full manure</th>
<th>2/3 manure 1/3 Fertilizer</th>
<th>check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg 12 sites</td>
<td>10.4</td>
<td>10.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg 11 sites</td>
<td>10.4</td>
<td>10.5</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>Avg 10 sites</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
<td>10.0</td>
</tr>
</tbody>
</table>
Manure on Wheat - Summary Field Scale

• Whenever manure was not effective the results were extremely negative, with the Ripley site (2009) suffering a 36 bu/ac yield loss.

• Recommendation: 2/3rds manure 1/3 fertilizer
  - avoided most of the significant yield loss concerns with manure only,
  - did not increase yields over fertilizer only
  - worked to maintain highest possible protein levels in the grain as well.
Manure On Forages - Research Scale

- **Treatments**
  1. Liquid dairy alfalfa 3000 gal/ac via drop hose applicator
  2. Liquid dairy alfalfa 6000 gal/ac via drop hose applicator
  3. Fertilizer P & K equivalent to 3000 gal/ac manure rate
  4. Liquid dairy alfalfa/grass mix 6000 gal/ac via drop hose applicator
  5. Liquid dairy alfalfa/grass mix 6000 gal/ac rolling tine
  6. Fertilizer P & K equivalent to manure 6000 gal/ac rate alfalfa/grass mix
## Manure vs Fertilizer on Forages – 2009 & 2010 Summary

### Average of all Cuts After Manure Application

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield - 2009</th>
<th>% Δ</th>
<th>Yield - 2010</th>
<th>% Δ</th>
<th>Yield + Quality - 2009</th>
<th>% Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons/ac</td>
<td></td>
<td>tons/ac</td>
<td></td>
<td>lbs milk / ac</td>
<td></td>
</tr>
<tr>
<td>Manure</td>
<td>1.13</td>
<td>7.1</td>
<td>1.55</td>
<td>9.7</td>
<td>3,352</td>
<td>11.7</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>1.09</td>
<td>3.7</td>
<td>1.47</td>
<td>4.8</td>
<td>3,180</td>
<td>6.9</td>
</tr>
<tr>
<td>Zero</td>
<td>1.05</td>
<td>---</td>
<td>1.40</td>
<td>---</td>
<td>2,959</td>
<td>---</td>
</tr>
</tbody>
</table>
Ammonia Loss Measurements
I ncorporate Manure to Minimize Ammonia Loss

What we know:
- The sooner incorporation occurs the lower the loss
- Ammonia volatilization is highest with surface applied manure to bare soil, during hot dry and windy conditions.

<table>
<thead>
<tr>
<th>Time to incorporation</th>
<th>Cool wet</th>
<th>Cool dry</th>
<th>Warm wet</th>
<th>Warm dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>10</td>
<td>15</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>5 days</td>
<td>20</td>
<td>30</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>Not incorporated</td>
<td>40</td>
<td>50</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Soil Fertility Handbook

What we don’t know:
- Impact of different incorporation designs and setup on loss
- Impact of application rate on incorporation
- Impact of manure applied during different seasons
Average Ammonia Loss from Manure Applied to Forages

2009 - Surface Application

Days After Application

Dosimeter Reading (ppm)

- Green average
- Kirwin ave
- MacKay ave
- Greive ave
- Nagelhout ave
- Rivers ave

R² values:
- 0.9949
- 0.999
- 0.9874
- 0.986
- 0.9591
- 0.9276
### Ammonia Loss Measurements

**Summary**

- ~75% loss when surface applied with no rainfall (hot dry conditions)
- Rainfall shortly after application reduces ammonia loss
- Partial incorporation will reduce ammonia loss (15-20%)
- Higher liquid content manure infiltrates more quickly; can reduce loss
- Uniform application probably as important as actual application rate
- Observation – 5 - 10 lb loss even where no manure is applied
From Producer Perspective - Looks Promising!

YIELD

12 % surface applied (2006)
7.2 % surface applied (2007)
7.1 % surface applied (2009)
9.7 % surface applied (2010)

QUALITY

5.6 % more milk per ton of forage where manure was applied (2006)
4.4 % more milk per ton of forage where manure was applied (2009)

YIELD + QUALITY

13.4 % advantage lbs milk per acre of forage (2006)
11.7 % advantage lbs milk per acre of forage (2009)
How Will Research Be Used?

- Fine-tune application: improve uniformity
- Utilize “hay in a day” technology: timely application
- Right time - right place - right rate
- Develop new application technology
- Evaluate economics
Partnerships

• Research – AAFC
• Farmer co-operators
• Soil & Crop Improvement Associations (Thames Valley)
• Grain Farmers of Ontario
• Extension

Future?:
• Equipment dealers/manufacturers (manure)
• Custom applicators
Questions?