Nutrient Losses during Temporary Field Storage of Poultry Manure

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THE ISSUES

• Temporary field storage is common in the Delmarva Region
• Is there evidence to suggest that after 14 days litter should be covered if stored in the field?
• Local growers suggest covering with poly is not very practical
• Current Delaware policy allows uncovered piles for up to 150 days if certain procedures are followed
Delaware Policy

• Six-feet tall in conical shape (90 days) and if ten-feet tall up to 150 days (conical shape)
• 100 ft from surface water; 200 ft from well
• When removing litter also remove top 1 to 2 inches of soil and spread it with manure
• Establish on well-drained soil
• Establish crop as soon as practical
Current Level of Knowledge

• No information on nutrient losses from “production-size” litter piles
• All previous information on nutrient losses is from small “research-size” piles
• Some previous studies have used poly under the research pile to collect runoff
• The DNMC et al. decided that information was needed on production-size litter piles
Objectives of this Work

• Determine the quantity and types of nutrients being lost from production-size piles
• Evaluate the impact of storage length (i.e., number of days) on nutrient losses
• Evaluate “alternative” methods of storage (i.e., something other than “nothing” or using a poly cover)
Methodology of Studies

• Large field-size piles
• Piles put out in fall (2005 and 2006) and removed in spring (2006 and 2007)
• **Pile 1:** Six “time-of-removal” treatments
  – 15, 30, 45, 90, 135, and 180 days
  – Seventh treatment: collected “runoff” from the pile for about 180 days
  – REPLICATED OVER TWO YEARS at two different locations
Methodology of Studies (Year 1)

Pile 2: Seven “ALTERNATIVE” treatments

- NO COVER
- POLY COVER
- Bentonite Clay as a BASE under the pile
- Spray-on carbon material at TWO rates
  (material used as a bedding material in North Carolina)
- Sawdust as a BASE under the pile
- Poultry Guard (ammonia control product; granulated sulfuric acid)
Methodology of Studies (Year 2)

• Pile 2: “ALTERNATIVE” treatments
  – NO COVER
  – POLY COVER
  – Soil Tac (spray-on polymer material) that was tested as a COVER and also as a BASE under pile
  – Illinois Silage Biodegradable Spray-On material tested as a cover
Methodology of Studies

• Runoff was collected whenever it occurred and we collected the total volume and subsampled it for nutrient concentration

• Soil samples were taken immediately after the litter was removed and then twice more about 1 and 2 months after removal

• Soil samples were taken from the following depths: 0-6”, 6-12”, 12-24”, 24-36”, and 36-48” (36-48” only in second year of study)
Soil Sampling and Analyses

• **YEAR 1**: Soil samples were taken outside the pile, on the edge of the pile, and under the pile the first year.

• **YEAR 2**: Samples were taken outside the pile (20 ft), 2 ft outside, on the edge, 2 ft inside the pile, and under the center of the pile.

• Soil was analyzed for ammonium-N, nitrate-N, soluble salts, total-N, and routine soil test (pH, P, K, Ca, Mg, S, Fe, Mn, Cu, and Zn). Below 12” depth was ONLY ammonium and nitrate.
RESULTS
COVERS
Soil Tac as a Spray-On Cover
Soil Tac as a Spray-On Cover
OBSERVATIONS
Three events: 0.94”
11/17/05 (0.8”)

November 17, 2005
Three events: 0.94”
11/17/05 (0.8”)

November 17, 2005
December 2, 2005

0.8” on 11/29/05
Total rain: 9.8”

March 20, 2006
DATA

Runoff
Ammonium-N (lbs) in 100’ x 18’

Mean = 16 lbs
Nitrate-N (mg N/liter)

Year 1

East  West
Nitrate-N (lbs) in 100’ x 18’

Mean = 0.8 lbs
Mean = 0.3 lbs
Total P (mg P/liter)

Year 1
Total P (lbs) in 100’ x 18’

Mean = 3.5 lbs

Year 1
Year 2
Year 3

East
West

Total P (lbs) in 100’ x 18’
Potassium (lbs) in 100’ x 18’

Mean = 113 lbs

Year 1
Year 2
Year 3

Whatman #2

East
West
Total S (mg S/liter)

- East
- West

Year 1
Total S (lbs) in 100’ x 18’

Mean = 32 lbs
Nutrient Losses from Leachate

(100 ft X 18 ft Pile Size @6’ height)
DATA

Soil
Three rainfall events = total of 0.94 inches; ZERO runoff events

Inorganic Nitrogen (ppm N)

15-Day Treatment

9 Nov = 0.04”
10 Nov = 0.10”
17 Nov = 0.80”

17 Nov 2005
185-Day Treatment

Eighteen rainfall events = total of 12.4 inches

Inorganic Nitrogen (ppm N)

- Under
- Edge
- Outside

5 May 2006
Loading to 3’ Depth

Assumed Pile Size: 100 ft X 18 ft

Inorganic Nitrogen (lb of N)

Days Pile was in Place

16
31
43
93
139
185

Year 1
Loading to 4’ Depth

Assumed Pile Size: 100 ft X 18 ft

Years:

- Year 2

Days Pile was in Place:

- 35
- 48
- 118
- 141
- 159
- 195

Inorganic Nitrogen (lb of N)
Loading to 3’ Depth

Assumed Pile Size: 100 ft X 18 ft

<table>
<thead>
<tr>
<th>Type of Cover or Base</th>
<th>Inorganic Nitrogen (lb of N)</th>
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<tbody>
<tr>
<td>None</td>
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<tr>
<td>Poly</td>
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<tr>
<td>BC</td>
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<tr>
<td>SC1</td>
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<td>SC2</td>
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<td>SD</td>
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<td>PG</td>
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</tbody>
</table>
Loading to 4’ Depth

Assumed Pile Size: 100 ft X 18 ft

None
Poly
ST1
ST2

Inorganic Nitrogen (lb of N)

Year 2
Pile in place for 123 days
POLY vs NO COVER (4 Reps)

Assumed Pile Size: 100 ft X 18 ft

Piles in place for at least 120 days

3 Years/4 sites
Range in Values Across All Sites

Assumed Pile Size: 100 ft X 18 ft

- **Min**: 2.0
- **Max**: 29.1
- **Mean**: 12.2
- **Median**: 11.7
- **SD**: 6.7

Inorganic Nitrogen (lb of N)

Piles in place for at least 120 days

Pile would contain about 100 tons

N = 31
185-Day Treatment – 0 days

Soil Phosphorus (ppm M3-P)

- Under
- Edge
- Outside

0-6"

6-12"
195-Day Treatment – Day 0

Soil Potassium (ppm K)

- Under
- 2' Under
- Edge
- 2' Outside
- 20' Outside

- 0-6"
- 6-12"
No Cover – Day 0

Soluble Salts (mmhos/cm)

- Under
- Edge
- Outside

0-6"
6-12"
SOLUBLE SALT CONCENTRATION IN SOIL (mmhos/cm)

SOIL POTASSIUM CONCENTRATION (mg M⁻³-K/kg)

SOIL SULFUR CONCENTRATION (mg M⁻³-S/kg)
Year 1

Salt = 0.0026K - 0.07
R² = 0.92

SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)

SOIL SULFUR CONCENTRATION (mg M3-S/kg)
Year 1

$R^2 = 0.92$

$\text{Salt} = 0.0026K - 0.07$

Year 2

$R^2 = 0.82$

$\text{Salt} = 0.0017K - 0.07$
Year 1

SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)

R² = 0.92
Salt = 0.0026K - 0.07

SOIL SULFUR CONCENTRATION (mg M3-S/kg)

R² = 0.93
Salt = 0.0104S + 0.23

Year 2

SOIL POTASSIUM CONCENTRATION (mg M3-K/kg)

R² = 0.82
Salt = 0.0017K - 0.07

SOIL SULFUR CONCENTRATION (mg M3-S/kg)
SOIL AMMONIUM CONCENTRATION (mg N/kg)  
SOIL NITRATE CONCENTRATION (mg N/kg)
Year 1

\[ R^2 = 0.02 \]

\[ \text{Salt} = 0.0081N + 1.01 \]

Year 2

\[ R^2 = 0.14 \]

\[ \text{Salt} = -0.0002N + 0.91 \]
Year 1

SOIL AMMONIUM CONCENTRATION (mg N/kg) vs. SOIL NITRATE CONCENTRATION (mg N/kg)

Year 2

SOIL AMMONIUM CONCENTRATION (mg N/kg) vs. SOIL NITRATE CONCENTRATION (mg N/kg)

Regression equations:

Year 1:
- Soluble salt concentration in soil (mmhos/cm): $R^2 = 0.02$
  - $Salt = 0.0081N + 1.01$
- Soluble salt concentration in soil (mmhos/cm): $R^2 = 0.01$
  - $Salt = 0.0053N + 1.16$

Year 2:
- Soluble salt concentration in soil (mmhos/cm): $R^2 = 0.14$
  - $Salt = 0.0114N + 0.56$
SOIL AMMONIUM CONCENTRATION (mg N/kg) vs. SOIL NITRATE CONCENTRATION (mg N/kg) for Years 1 and 2.

**Year 1**
- **SOIL AMMONIUM CONCENTRATION**
  - \( R^2 = 0.02 \)
  - Salt = 0.0081N + 1.01

**Year 2**
- **SOIL AMMONIUM CONCENTRATION**
  - \( R^2 = 0.14 \)
  - Salt = 0.0114N + 0.56

**SOIL NITRATE CONCENTRATION**
- **Year 1**
  - \( R^2 = 0.01 \)
  - Salt = 0.0053N + 1.16

- **Year 2**
  - \( R^2 = 0.00 \)
  - Salt = -0.0002N + 0.91
Summary and Conclusions

• All spray-on covers didn’t provide a benefit and were sometimes worse
• Nutrients are being lost from poultry piles
• The nutrient being lost in the greatest amounts (about 8 times) is potassium
• Potassium concentrations are the main contributor to soluble salts concentrations
• Poly covers provided no benefit for N losses
• Nitrogen is lost from piles both as leachate (edges) and probably as ammonia gas
Summary and Conclusions

• Nitrogen is being lost from litter piles to the soil and because of limited to no plant growth is most likely being lost to the environment.

• These amounts should be kept in perspective.

• Piled litter has less potential for nutrient losses than litter spread at the “wrong time”.

• Establishment of growing plants in these areas would reduce these potential losses.

• Current regulations should be followed!!!
WMP = WORST MANAGEMENT PRACTICE