Measuring Ammonia Loss from Partially Incorporated Manure Applied to Forages

(2007 Interim Report)

Purpose:

To measure ammonia loss from liquid manure applied to alfalfa-grass forages.

Manure application to growing crops – particularly corn - is most economical from a nitrogen needs perspective, but is also most environmentally friendly, since nitrogen applied when a crop can use it minimizes the loss from leaching or loss as a green house gas. Application to a forage crop immediately after harvest can reduce storage requirements, maximize time, labour and/or equipment resources and can minimize compaction. However, if summer applied manure is not incorporated; nitrogen loss from the ammonium portion can be significant.

In 2006 application of liquid manure to 8 forage fields resulted in an average 13.4% increase in lbs of milk produced per acre of forage. Surface application was compared to no manure or commercial K only and to rotary tine system (Aerway) and slot injection (Kaweco). The rotary tine system resulted in a yield reduction compared to surface application. In 2007 manure was applied to forages to answer the question: how much nitrogen is volatilized from partially incorporated manure applied to alfalfa forages using calibrated “ammonia traps”? If the loss is reduced by partial incorporation, does this make up for the negative yield impact? Manure applied to forages in 2007 also gave the opportunity to re-evaluate yield and quality results under different growing conditions.

Methods:

Surface applied manure was compared to no manure and partial incorporation applications (rotary tine and slot type injection systems as well as a drop hose system).

- This project was implemented on 4 forage fields (ranging from 1st full production year to 4th production year and most fields having a mix of legumes and grasses).
- After 1st cut harvest,~4000 gal/ac liquid dairy manure was applied, in replicated treatments for the rotary tine system and the slot injection system.

Aerway Rotary Tine System

- Surface applied manure
- No manure applied
- Aerway injection -no manure
- Aerway injection - with manure

Kaweco Slot Injection System

- Surface applied manure
- No manure applied
- Slot injection - no manure
- Slot injection - with manure

- After 2nd cut harvest, liquid dairy manure was applied, in replicated treatments for a drop hose system with treatments as follows:

Drop Hose System

- Surface applied manure @ 2,200 gal/ac
- Surface applied manure @ 4,000 gal/ac
- No manure applied
- Drop hose application @ 4,800 gal/ac

A manure sample was taken from each site at time of application and sent for analysis. Ammonia traps – dosimeter tubes, set 1 ft above the surface attached to rebar and covered with a white pail (12 to 14 per field) were set up seconds after manure application to each treatment. Tube readings were taken every day for 10 days after application. Numbers from the dosimeter tubes were converted from ppm.hr to lbs/ac based on calibrations done by Dr. J. Lauzon, U of Guelph.

- Harvest data was taken from each treatment for each cut after manure application. Several samples were also taken for harvests prior to manure application to reflect season long yield.
- Harvest was done using a hoola-hoop and clippers. Samples were weighed, dried down and weighed again to calculate moisture at harvest. Dried samples were analyzed for feed value. Grass/alfalfa content of some samples was measured by separating the grass and alfalfa.

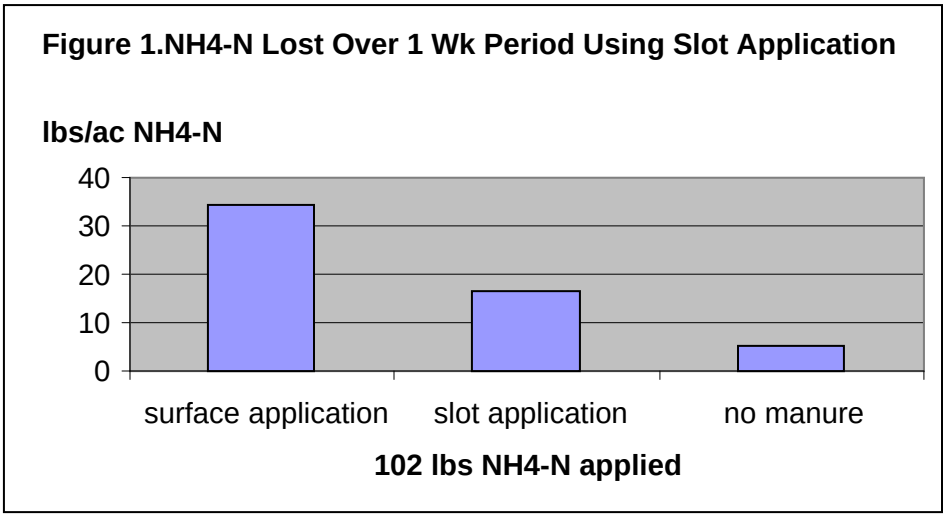
Results:

Freshly harvested alfalfa forage does not have much living material or much residue. Ammonia loss estimates for manure applied to bare soils during warm dry conditions is estimated to be close to 100% based on nutrient management planning tables. Losses when manure is applied to a living crop or to crop residue are less (50-70%).

Manure applied to all treatments was applied near mid-day during sunny 30°C days with gusty winds. For ammonia loss predictions these conditions would represent a worst case scenario for loss.

Slot application appeared to give the most uniform application (Figure1). This system was set up with 20 injection coulters at 7 inch spacing's that penetrated the soil ~2.5 cm followed by manure applied into the slots at a rate of about 200 gal/ac per row (4000 gal/ac). Manure composition was low dry matter (watery), resulting in rapid infiltration. In the surface application treatments, there were several areas where manure ponding occurred due to un-even application. Ammonia measurements in these areas showed large (90% of total) losses compared to small (10% of total) losses where application was more uniform and at the intended rate.

Figure 1.NH4-N Lost Over 1 Wk Period Using Slot Application

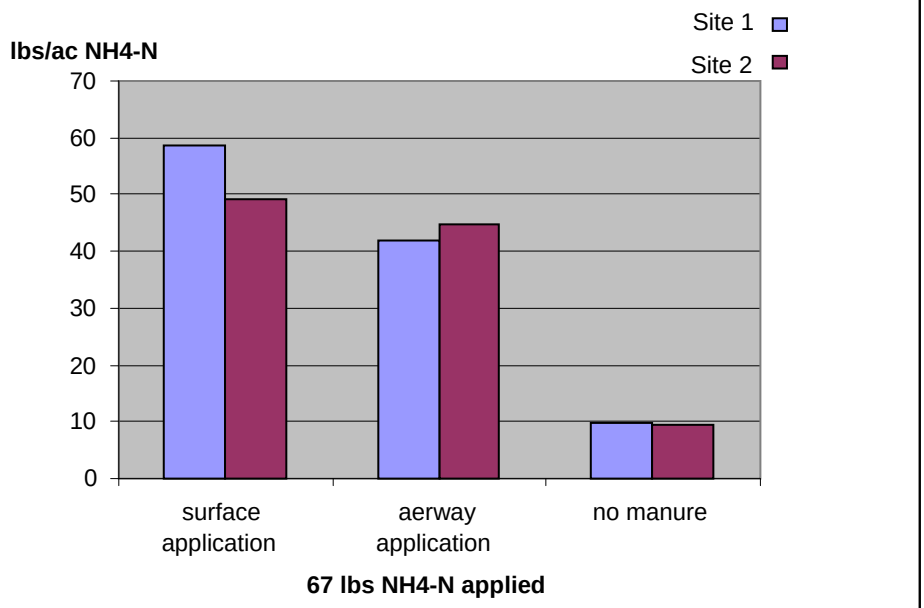


~12mm rain 30 hrs after application

Rainfall as been assumed to naturally incorporate manure nutrients (nitrogen). 12 mm of rain fell about 30 hours after manure was applied. Ammonia loss from that point on was reduced to less than 6 lbs/ac.

Rotary Tine (Aerway) application was done at 2 sites in the same neighbourhood (Figure 2). The aerway operation was done within 1 hour of manure application. Manure was applied at 4200 gal/ac to both sites using the same manure source, same equipment and same application rate. Site 1 was a 4th year alfalfa stand on heavier soil and was suffering from moisture stress, while site 2 was a 2nd year stand on a loamier soil.

Figure 2. NH4-N Lost Over 1 Wk Period With Aerway Application



Aerway operation was done ahead of manure application as a separate application

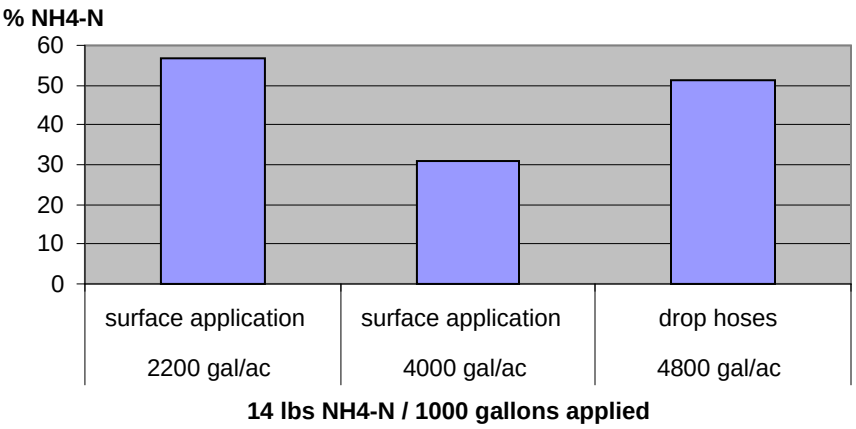
Aerway incorporation did show a reduction in ammonia retained. In situations where the aerway operation and manure application are done in the same pass, simultaneously, the ammonia retention might be higher because manure is applied behind the aerway teeth and not over the whole surface.

Drop hose application does not incorporate manure, but does lay it on the surface without splash of potential to drift (Figure 3). The dry matter content of the manure applied at this site was about 8% (fairly thick). Manure applied in narrow bands in 7 inch spacing's left concentrated strips that took longer to infiltrate and gave more opportunity for volatilization. The surface applied manure at the higher rate had a lower % ammonia loss than the manure applied at the half rate. The reason for this in unclear, but may reflect similar infiltration times for both application rates but more nitrogen in the 4000 gal/ac rate.

Where no manure was applied there was still a measurable ammonia loss – between 5 and 10 lbs/ac. This is most likely the breakdown of leaves left on the surface or plant root losses when no top growth is feeding the nodules.

Yield and quality results from 2006 and 2007 will be summarized in the final report.

Figure 3. NH4-N Lost Over 1 Wk Period With Drop Hose Application



Thunder storm <1mm drizzle ~ 6 hrs after application

Summary:

Surface Applied	• Even in warm, dry weather – worst case scenario conditions for ammonia loss from surface applied manure – losses were never 100%.
	• 75% of the ammonium-N applied was lost as ammonia over a 1 week period after application
	• 25% of the ammonium-N applied was lost as ammonia over a 1 week period when 12 mm rain fell within a day of application
	• Uniform application seems to be as important as the actual application rate (for rates under 5000 gal/ac)
	• Application as soon after harvest is even more critical in dry years when plants are suffering from moisture stress. Tire track damage from application equipment was much more pronounced in drier areas of the field.

Partial Incorporation	• 60-65% of the ammonium-N applied was lost as ammonia over a 1 week period after application
	• Partial incorporation reduced ammonia loss by an average 13% (10 to 25% range)
	• Regardless of application method, about 70-75% of the ammonia lost was volatilized during the 1st 24 hours after application
No Manure	• About 5-10 lbs/ac of ammonia was measured in all the treatments where no manure was applied.

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