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REDUCING AMMONIA VOLATILIZATION BY IMPROVED TECHNIQUES OF FIELD APPLYING MANURE SLURRY TO GRASSLAND

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AERWAY-SSD manure applicato


The AERWEAY-SSD manure applicator, banding manure slurry directly over surface openings made by aerator tines.


SPLASH-PLATE, conventional broadcasting of manure


A SPLASH-PLATE treated plot with perimeter masts and chambers.

Introduction

- Scientists at the Pacific Agri-food Research Centre of Agriculture and Agri-Food Canada, in collaboration with Holland Hitch Ltd., have developed a new precision, high-speed implement for applying liquid manure into the soil of grassland, minimum-tilled crop land as well as conventionally
- The new applicator, called Aerway SSD, applies slurry in narrow bands directly over surface openings made by its ground-driven aerator tines, in one operation.
- Compared to broadcasting with a conventional splash-plate applicator, the Aerway SSD applies manure more uniformly and with less exposure to the air
- Compared to conventional injectors, SSD causes less soil disturbance, requires less power, can be used on stony land, and is available in wider units.
- Scientific evaluation of this new technology was started in 1999 in order to assess agronomic crop response, nutrient use efficiency, and ammonia loss relative to conventional manure application.
- This poster summarizes results for 8 trials over two years of a study to compare ammonia loss from dairy slurry applied on grassland with the Aerway SSD (AERWAY), surface banding with drop hoses (HOSE) and conventional broadcasting with a splash-plate (SPLASH-PLATE).

Measurements of Ammonia Loss

There are different methods for measuring volatilization losses of ammonia following land application of manure.

1. The micro-meteorological method uses small passive-flux samplers mounted at different heights on towers located around the perimeter of a treated area. This method relies on wind speed and direction, requiring large plots (at least 20 by 20m).

2. In contrast, the semi-open chamber technique does not require large plots so a larger number of treatments can be monitored at once. However, these chambers restrict airflow, reducing ammonia loss, and hence capture smaller amounts of ammonia than other methods.

CHAMBERS
The semi-open chamber consists of a rigid plastic 31-cm diameter PVC tube. Ammonia was trapped in 2.5-cm sorption pads soaked in phosphoric acid and positioned 25-cm above the soil surface. Plastic roofs prevented rain from entering the chambers. Three chambers were used for each experimental plot.

PASSIVE-FLUX SAMPLERS
A sampler consists of a pair of acid-coated glass tubes connected with a piece of silicone tubing. In addition, a 1-cm long glass tube with one end having a stainless steel disc, containing a 1-mm hole, was attached to one end of the unit. At all plots, four 3-m long masts were erected on the perimeter at 90° angles (north, east, south, west). On each perimeter mast, at heights 25, 50, 100, and 300-cm above the soil surface, two passive-flux samplers were mounted.

Experiments

- Five trials were conducted on a 5-6 year-old stand of tall fescue using chambers and three trials on a 2-3 year-old stand of orchardgrass using both chambers and passive-flux samplers.
- Manure application rates ranged from 70 to 115 kg ammonia-N/ha and from 55,000 to 75,000 l/ha.
- The splash-plate spread a 9-m wide strip; the SSD unit (also used for the drop hose treatment) was 4.5 m wide.
- The bands of both the drop hose and the SSD treatments were spaced 19 cm apart. The soil openings made by the Aerway SSD, set at 2.5 degree offset, measured 15- to 18-cm deep, 20-cm long and were spaced 19-cm apart.
- Ammonia samples were typically collected 1, 2, 3, 7, and 14 days after manure was applied. Ammonia extracted from the sorption pads and tubes was quantified with a flow injection auto-analyser.


A HOSE (surface banding with drop-hoses) treated plot with chambers.


An AERWAY-SSD treated plot with chambers.


Chamber with sorption pad.


Soil aerator holes (2 cm wide, 20 cm long, 14 cm deep)


A Passive-Flux Sampler.


The semi-open chamber method for measuring volatilization losses of ammonia.


Chamber showing plastic roof and top sorption pad to avoid contamination from ambient air.


Manure slurry bands, HOSE applied, one week after application.

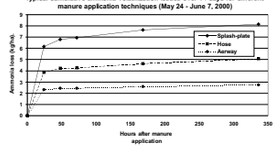

An AERWAY-SSD treated plot with perimeter masts and chambers.

Typical ammonia volatilization losses from dairy manure slurry for different manure application techniques (May 24 - June 7, 2000)

	Treatment		
	Splash-plate	Hose	Aerway
	Ammonia loss (kg ha^{-1})		
Shift 1	6.17a[z]	3.86b2	.32b
Shift 2	0.62a	0.37b0	.12c
Shift 3	0.16a	0.03b0	.01b
Shift 4	0.69a	0.40a	0.16b
Shift 5	0.50a	0.40a	0.14b
Total	8.14a	5.05b2	.76c

[z] Values followed by the same letter are not statistically different at P<0.05 according to Fisher's protected LSD test.

Typical cumulative ammonia volatilization losses over 14 days for different manure application techniques (May 24 - June 7, 2000)



Summary of cumulative ammonia volatilization losses over 14 days from dairy manure slurry for different manure application techniques

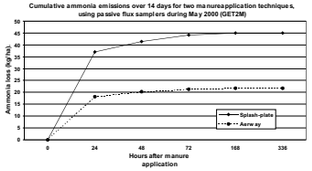
	Treatment		
	Splash-plate	HoseA	erway
	Ammonia loss (kg ha^{-1})		
A. TALL FESCUE			
1999			
Trial 1 (July 21-August 3)	7.36	6.86	4.85
Trial 2 (August 17-Sept.1)	9.58	5.07	4.91
2000			
Get3C (May 24-June 7)	8.14	5.05	2.76
Get4C (July 25-August 8)	6.45	2.26	1.93
Get7C (September12-26)	4.16	1.87	0.70
AVERAGE	7.14	4.22	3.03
		-41%	-58%
B. ORCHARD GRASS			
1999			
Trial 3 (September 1-14)	13.21	-	4.97
2000			
Get2C (May 16-30)	5.76	-	3.11
Get5C (Aug. 24-Sept.7)	7.39	-	3.37
AVERAGE	8.79	-	3.82
			-56%


AERWAY-SSD applied manure slurry bands.


A pair of Passive-Flux Samplers on mast


Micro-meteorological station for measuring wind direction (at 1m height), wind speed and air temperature at four heights.

Cumulative ammonia emissions over 14 days for two manure application techniques, using passive flux samplers during May 2000 (GET2M)



Comparison of two methods of measuring ammonia volatilization losses over 14 days from dairy manure slurry on grassland
(Ammonia Loss in kg ha^{-1})

	PASSIVE-FLUX SAMPLERS		CHAMBERS	
	Splash-plate	Aerway SSD	Splash-plate	Aerway SSD
Sept.1-14, '99				
Shift 1	37.2	13.1	8.6	3.7
Shift 2	3.6	3.2	1.6	0.5
Sum	40.9	16.3	10.2	4.2
		-60%		-59%
May 16-30,'00				
Shift 1	33.3	16.5	3.8	2.3
Shift 2	3.7	1.9	0.3	0.1
Shift 3	2.4	2.5	0.2	0.1
Shift 4	2.4	1.4	0.7	0.3
Shift 5	1.9	0.1	0.8	0.4
Sum	43.7	22.4	5.8	3.1
		-49%		-46%

Observations

1. Results from all 8 trials showed significantly lower ammonia emission losses for the Aerway SSD manure applicator compared with the splash-plate. Average reduction in ammonia emission loss by the Aerway SSD, over the eight trials, was 57%.
2. Results for banding manure with the drop hoses were less consistent, but on average (41% reduction), intermediate between the splash-plate and the SSD.
3. Over half of the total amount of ammonia loss occurred during the first day in all trials; this proportion was greater for the splash-plate than the Aerway SSD.
4. Differences among manure application methods were less apparent after Day 2 (Shift 2).
5. There is good agreement between the two methods of measuring ammonia volatilization.
6. Ammonia emissions into the atmosphere are substantial when manure is broadcast-applied, on average 40% of the amount applied as manure.

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