

Minimizing nitrate loss from manure-amended Wisconsin sandy soils



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Justification and Objectives

Justification:

Large confined dairy animal feeding operations are moving into the Central Sands area of Wisconsin and many are using solid-liquid manure separation technology. There is great public concern about how these large dairies will impact groundwater quality, especially when $\text{NO}_3\text{-N}$ levels are already greater than 10 mg L^{-1} in some wells.

Objectives:

1. Determine the impact of spring applied separated-liquid and separated-solid manure on nitrate leaching.
2. Evaluate the effectiveness of Instinct™ nitrification inhibitor (nitrapyrin, Dow AgroSciences) on reducing nitrate leaching from separated-liquid manure.

Methods

Locations:

- Coloma (Billet sandy loam)
- Grand Marsh (Billett and Richford loamy sand)



Split-Plot Study Design:

- Main Plot: Manure treatment
 - Separated-solid, separated-liquid, separated-liquid + Instinct™, no manure
- Subplot: Nitrogen fertilizer rate
 - 0 or 112 kg N ha^{-1} sidedress in manure plots
 - 0, 112, or 224 kg N ha^{-1} sidedress in no manure plots
- 4 replications
- Subplot size of four 0.76 m rows by 10.64 m long

Growing Season Activities:

- Manure applied April 24 and 25
 - Liquids injected 20 cm below the surface at 131 kL ha^{-1}
 - Instinct™ applied at 2.6 L ha^{-1} (where applicable)
 - Solid broadcast at 40.3 Mg ha^{-1}
 - Separated-solid manure and no manure plots were chisel plowed within one hour of application of separated-solid manure
- Both fields were planted on May 11
- Sidedress: June 11 injected 28% urea ammonium nitrate (UAN)
- Ceramic suction cup lysimeters installed 1.5 m deep on May 22 and 24
- Standard crop management practices were employed including center pivot irrigation

Water Collection:

- Samples collected weekly from installation until two weeks after harvest
- Samples stored in refrigerator at 39°F
- $\text{NO}_3\text{-N}$ analyzed using the single reagent method with vanadium chloride as a reductant (Doane and Horwath, 2003)

Statistical analysis:

- Nitrate data was transformed by square root to improve normality
- A mixed model with manure treatment and N fertilizer rate as fixed effects and time as the random effect was used for analysis
- Tukey's LSD ($\alpha = 0.10$) was used for means separation

Results

Table 1: Total N applied, $\text{NH}_4\text{-N}$ applied, estimated first-year N availability, dry matter, and C:N ratio of applied manures.

Location	Manure	Total N applied	$\text{NH}_4\text{-N}$ applied	First-year Est. N Availability	Dry Matter	C:N ratio
Coloma	Separated-liquid	462	276	231	5.6	5
	Separated-liquid + Instinct™	478	279	239	5.9	5
	Separated-solid	147	43	52	34.8	24
Grand Marsh	Separated-liquid	480	278	240	5.6	5
	Separated-liquid + Instinct™	496	287	248	6.7	6
	Separated-solid	155	43	54	35.0	22

Table 2: Means separation for $\text{NO}_3\text{-N}$ leached throughout the growing season from manure and no manure plots. Within each location, treatments with the same letter are not significantly different ($p > 0.10$).

Manure	N rate	Coloma	Grand Marsh
		Letter group by location	
Separated-liquid	0	AB	BC
	112	A	A
Separated-liquid + Instinct™	0	C	B
	112	B	A
Separated-solid	0	E	E
	112	D	D
No manure	0	E	E
	112	DE	CD

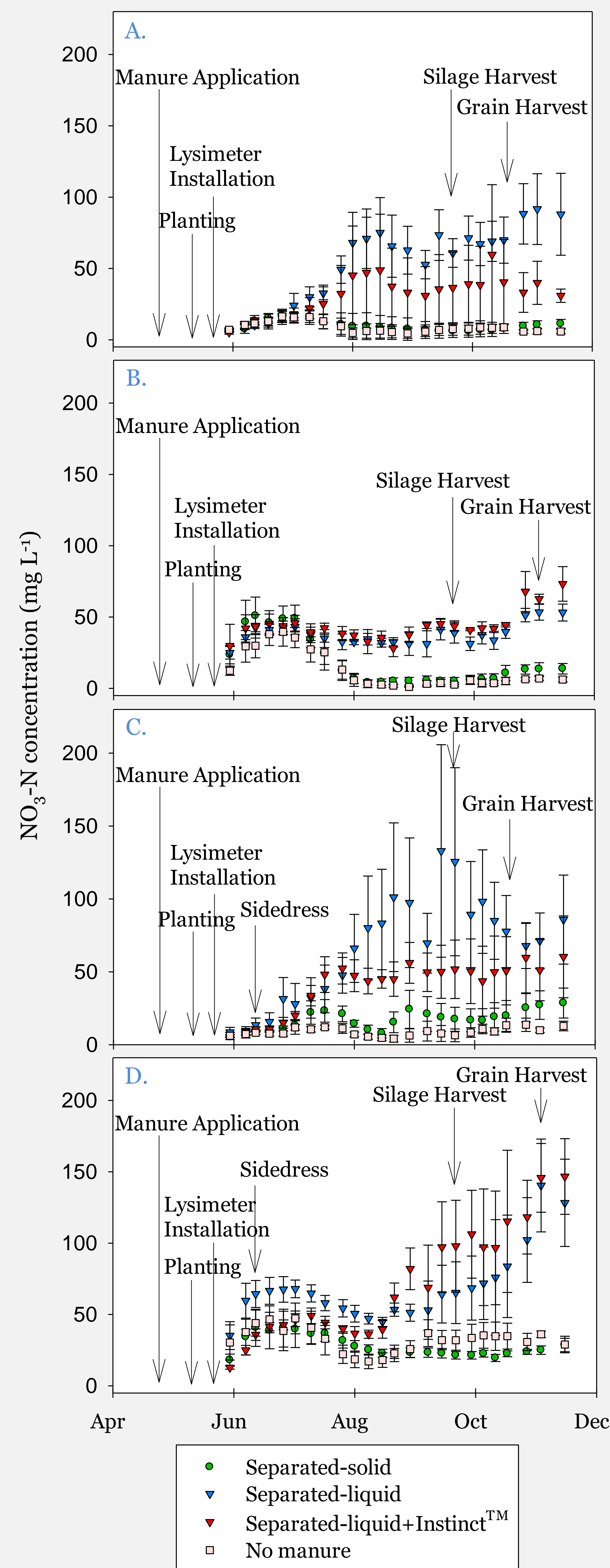


Figure 1: $\text{NO}_3\text{-N}$ concentrations (mg L^{-1}) in ceramic suction cup lysimeters. No sidedress N applied at Coloma (A) and Grand Marsh (B). 112 kg N ha^{-1} sidedressed at Coloma (C) and Grand Marsh (D).

Summary

Less $\text{NO}_3\text{-N}$ leaching was observed where separated-solid manure was applied compared to separated liquid manure (Table 1 and Figure 1, $p < 0.10$) at both locations. This may be attributed to:

- The separated-solid manure had a lower total N and $\text{NH}_4\text{-N}$ application rate and lower estimated N availability than the separated-liquid manures (Table 1).
- Separated-liquid manures are more prone to macropore movement (Robbins, 2004).
- Separated-solid manures had high C:N ratios and laboratory studies have found that manures with similar ratios can immobilize N (Earhart, 2009). However, there were no visual signs of N deficiency in the crop.

Instinct™ reduced nitrate leaching where separated-liquid manure was applied at Coloma but not at Grand Marsh (Table 1 and Figure 1).

- Grand Marsh had a higher OM content than Coloma (1.6 versus 1.2%, respectively).
- Grand Marsh received 2.3 cm of irrigation water in two applications from May 16 to June 3, while the first irrigation at Coloma took place on June 3. Grand Marsh received a larger total amount of irrigation water (30.5 versus 33 cm, respectively) throughout the summer.
- Perhaps, the greater OM at the Grand Marsh site resulted in less movement of the nitrapyrin (Wolt, 2000; Touchton et al., 1978), while some of the N was able to mineralize, nitrify, and leach out of the manure application zone before it could interact with nitrapyrin.
- In addition Grand Marsh had a higher pH than Coloma (6.6 versus 6.2, respectively), which may have increased the degradation of the nitrapyrin (Touchton et al., 1978).



Literature Cited

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