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Precision Injection of Dairy Slurry to Improve Nutrient Uptake: Benefits and Risks

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The Problem

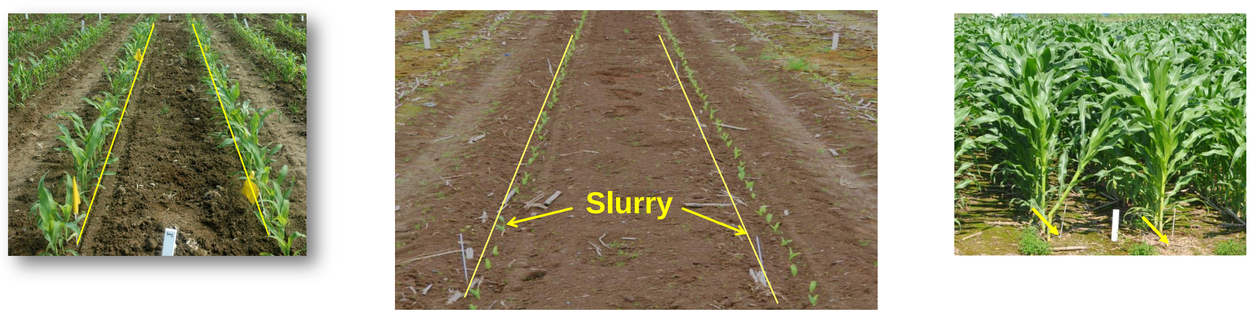
- Dairy farmers apply fertilizers (N+P), including starter, to silage corn even when there are surplus nutrients; evidence shows it improves yield and maturity (unpublished data).
- Recent work suggests that precision injecting (see M&M) slurry manure improves nutrient uptake, especially P, compared to broadcasting (Bittman et al. 2006, Bittman et al. 2012, Schröder et al. 2015), but there are also reports of no benefit (Peterson et al. 2013).
- There is no information on crop response and environmental impact from multi-year slurry injections.

Message

- Precision injection of dairy slurry increased silage yield and uptake of N and P compared to broadcasting.
- Precision injection fully matched mineral fertilizer but with higher N and P.
- Precision injection had a small effect on NO_3 leaching but significantly increased N_2O emissions, which was mitigated with a nitrification inhibitor.
- **Precision injection can help reduce nutrient surplus on dairy farms.**

Objectives

1. To compare growth and recovery of N and P by corn from precision injected dairy slurry vs. broadcast slurry or mineral fertilizer over 5 years.
2. To assess possible unintended consequences of precision injected slurry: nitrous oxide (N_2O) emissions and nitrate (NO_3) leaching.



Corn emergence and growth showing positions of the slurry injection furrows.

Materials and methods

Precision injection

Dairy slurry injected to 12-15 cm depth at corn row spacing

Corn planted at <10 cm from injection furrow after a few days when slurry soaked into ground.

Trial duration (5-years)

Treatments

Nutrient source	Method	Mineral Starter	N rate (kg/ha)	P rate (kg/ha)
Control	-	-	0-244	0-64
Fertilizer	Broadcast	+	0-244	0-64
Slurry	Broadcast	-	80-244	13-39
Slurry	Inject	-	81-244	13-39
Slurry	Inject	+	105-268	45-71

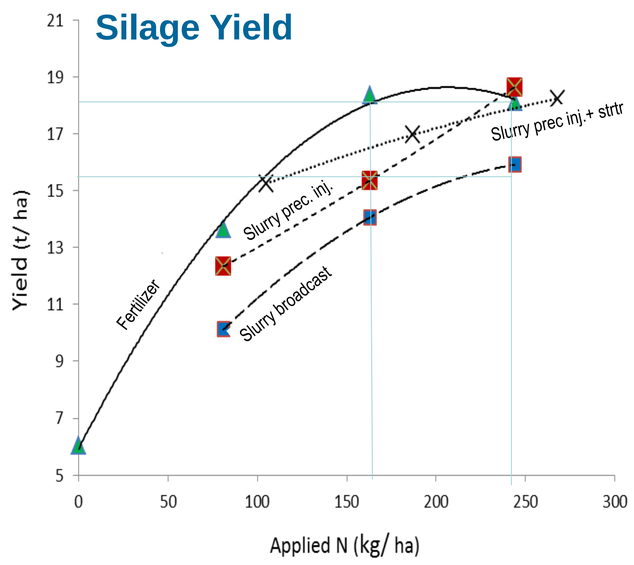
Table 1. Nutrient types/methods and rates with and without mineral starter (24N and 32P). Treatments were repeated on same plots.

Measurements

N_2O measured with static chambers over 5 yrs. Nitrification inhibitor dicyandiamide (DCD) mixed with manure. Suction lysimeters collected soil water samples for NO_3 analysis.

Results

Silage Yield



P uptake (6-leaf stage)

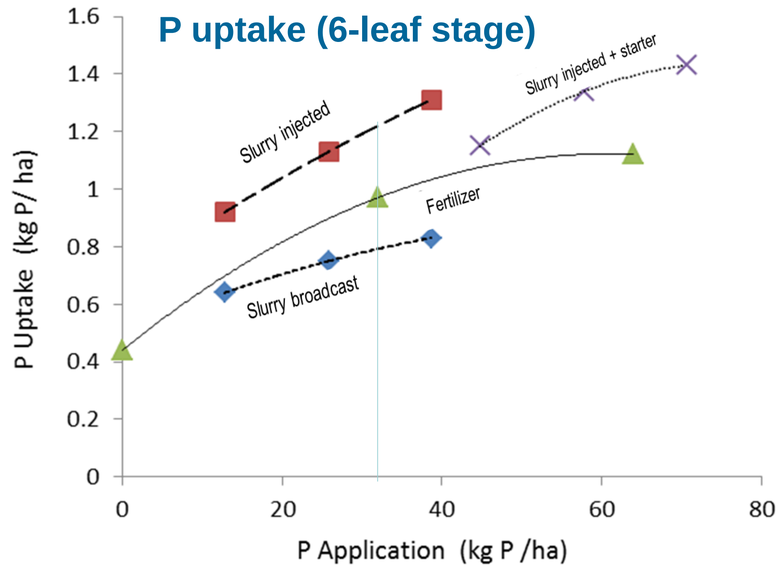


Fig. 1. Effect of nutrient sources and rates on corn silage yield (left) and P uptake at 6-leaf stage (right). Data are means of 5 years. Vertical blue lines show key application rates of N and P. Note: All nutrient sources, averaged over 3 rates, are significantly different at P<0.05 for yield and uptake of N and P.

Discussion

- Precision injection improved corn response to N and P from dairy slurry compared to broadcasting (Fig. 1).
- *Injected slurry can replace mineral fertilizers and reduce nutrient loading on dairy farms with following provisos:*
  - Maximum yield (18.5 t/ha) with mineral fertilizer at 160 kg N/ha; at this N rate injected slurry yielded 3.5 t/ha less than fertilizer (Fig 1).
  - Maximum yield (18.5 t/ha) was also reached with injected slurry but at 240 kg N/ha and 8 kg/ha extra P.
  - N_2O emission factors: fertilizer<broadcast slurry<injected slurry <injected slurry at maximum yield; N2O mitigated with DCD (Fig 2).
  - Little increased NO3 leaching (Fig 3).
- Precision injection can help farms reduce *inputs and surplus N and P.*

N_2O Emissions

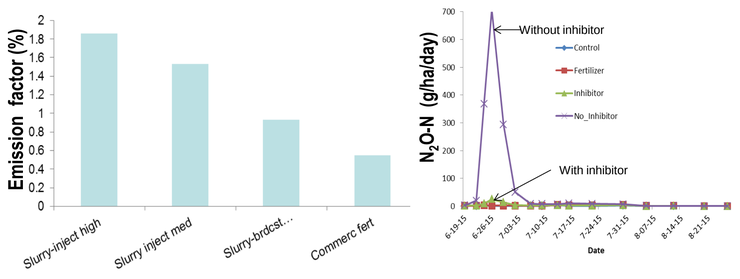


Fig. 2. (Left) Nitrous oxide (N_2O) emission factors (emitted N_2O-N over control as % of applied) for different nutrient sources. (Right) Mitigation of N_2O emission (g N_2O-N/ha/day) with nitrification inhibitor DCD.

NO_3 Leaching

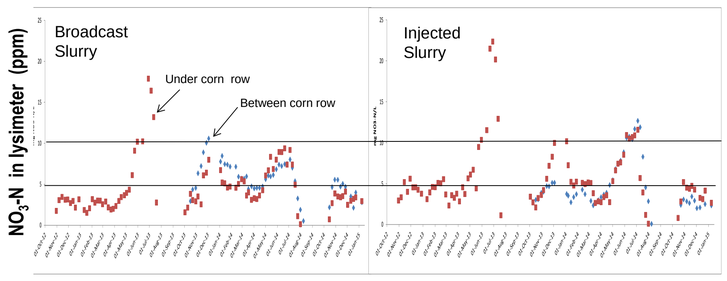


Fig. 3. Concentration of NO_3-N in suction lysimeter samples taken under corn rows (red) and between corn rows (blue) for broadcast slurry (left) and injected slurry (right).

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