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

Shabtai Bittman¹, Derek Hunt¹, Coby Hoogendoorn², and Hongjie Zhang¹

¹Agriculture and Agri-Food Canada, Box 1000, Agassiz, BC, Canada, V3M 1A0, derek.hunt@agr.gc.ca
²Independent Researcher, 15 Beattie St, Feilding, New Zealand, 4772

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including starter, to silage corn even when there are surplus nutrients; evidence shows it improves yield and maturity (unpublished data).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 NO₂ 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 (N₂O) emissions and nitrate (NO₃) leaching.

Results

- 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.

Materials and methods

- Precision injection

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 provision:
  - Maximum yield (18.5 t/ha) with mineral fertilizer at 160 kg N/ha.
  - Precision injection at 120 kg N/ha reduced N₂O emissions, which was mitigated with a nitrification inhibitor.
- Precision injection can help farms reduce nutrient surplus on dairy farms.

References


Materials and methods

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

Fig. 2. Nitrous oxide (N₂O) emission factors (emitted N₂O/NO over control as % of applied) for different nutrient sources. (Right) Mitigation of N₂O emission (g N₂O-N/ha/day) with nitrification inhibitor DCD.

Fig. 3. Concentration of NO₃-N in suction lysimeter samples taken under corn rows (red) and between corn rows (blue) for broadcast slurry (left) and injected slurry (right).

Fig. 4. Silage yield and uptake of N and P over 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.

Trial duration (5-years)

- Table 1. Nutrient types/methods and rates with and without mineral starter (24N+8P). Treatments were repeated on same plots.

Measurements

- N₂O measured with static chambers over 5 yr. Nitrification inhibitor dicyandiamide (DCD) mixed with manure. Suction lysimeters collected soil water samples for N₂O analysis.

- N₂O emission factors: fertilizer<broadcast slurry<injected slurry

- Fig. 2. N₂O emissions from precision injected slurry compared to broadcasting (Fig. 1).
- Injected slurry can replace mineral fertilizers and reduce nutrient loading on dairy farms with following provision:
  - Maximum yield (18.5 t/ha) with mineral fertilizer at 160 kg N/ha.
  - This N rate injected slurry yielded 3.5 t/ha less than fertilizer (Fig 1).
  - Precision injection decreased N₂O emissions, which was mitigated with a nitrification inhibitor.
- Precision injection can help farms reduce nutrient surplus on dairy farms.