Assessing Greenhouse Gas Emissions of Dairy Manure from Tannin in Feeding Trials

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SUSTAINABLE DAIRY SCIENCE FOR SUSTAINABLE PRODUCTION

Objectives

- Quantify greenhouse gas emissions from tannin derived manures (herein tannin manures) and determine if tannin manures are a potential mitigation option at the field level.
- Determine tannin manure soil N concentrations during the growing season.
- Determine yield response to tannin enhanced manures.

Conclusions

- There were treatment differences in N_2O or CO_2 flux over the growing season. Seasonal emission loads showed significant treatment effects.
- Soil N concentrations were significantly impacted by tannin treatment over the first four days of the growing season.
- Yield was not significantly different across treatments.

Justification

Dairy production systems and manure land applications are responsible for part of livestock emissions from agriculture. Adding tannin compounds to feed for dairy cows has proven to mitigate up to 70% of ammonia emissions in laboratory experiments. Emissions from land application of manure have not been studied at the field scale.

Methods

Experimental Design

- A randomized complete block design with six manure treatments and a no manure control plot were applied to a corn for silage system at the Dairy Forage Research Center in Prairie du Sac, Wisconsin.
- Three tannin levels, 0, 0.45, 1.8% dry matter intake (DMI), were applied at two targeted N rates, 240 kg N ha^{-1} and 360 kg N ha^{-1}.
- Manure application rate was determined using Leco TN content one month prior to application.

Greenhouse Gas Emissions

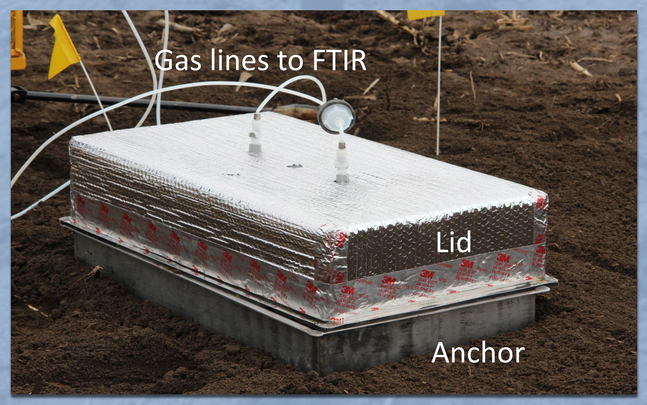
- CO_2 and N_2O concentrations were taken using Fourier Transform Infrared Spectroscopy (FTIR) with static flux chambers.
- Measurements were taken for the first four days and every 7-10 days through the growing season.
- Seasonal emissions loads were determined by prorating average treatment flux to represent days surrounding a sampling event.

Soil N Measurements

- Samples were taken bi-monthly and analyzed using a Lachat for NO_3^--N and NH_4^+-N.

All statistical analyses completed with a mixed model, repeated measures program in SAS.

Static Flux Chamber



Greenhouse Gas Flux and Soil N Results

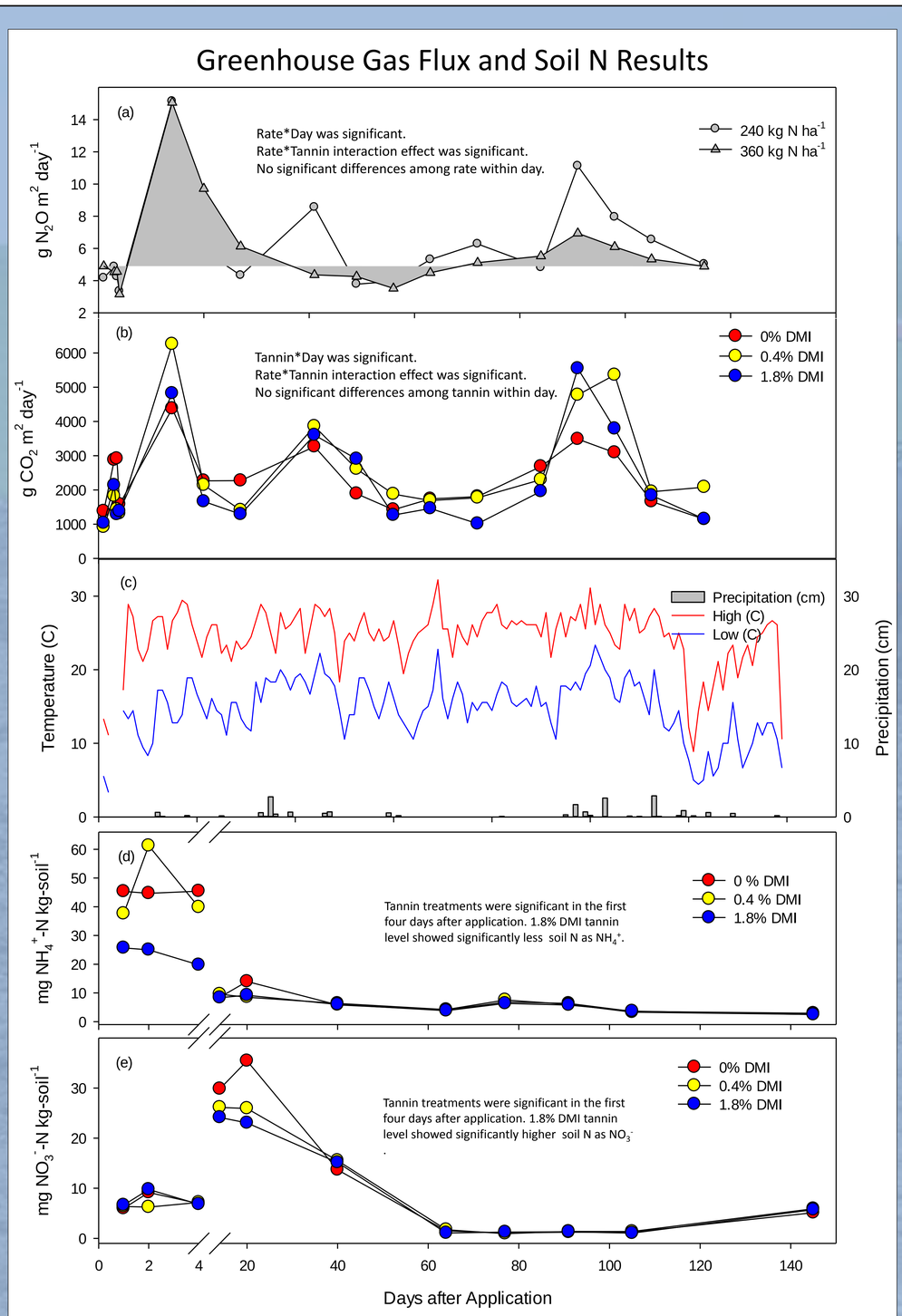


Figure 1. Gas flux for (a) N_2O and (b) CO_2 with (c) daily weather and soil (d) NH_4^+ and (e) NO_3^- for the growing season following manure applicaiton on May 15, 2014. Corn was planted on May 19, 2014 and harvested on September 17, 2014.

Soil Nitrogen

- Soil NH_4^+ was significantly lower (P<0.05) in the high tannin diet in the first four days following application.
- Soil NO_3^- was significantly higher (P<0.05) in the high tannin diet in the first four days.

Total Nitrogen in Manure

- Total nitrogen in manure was significantly different at the time of manure collection,
- At land application, nitrogen losses resulted in TN concentrations to be similar among diets.

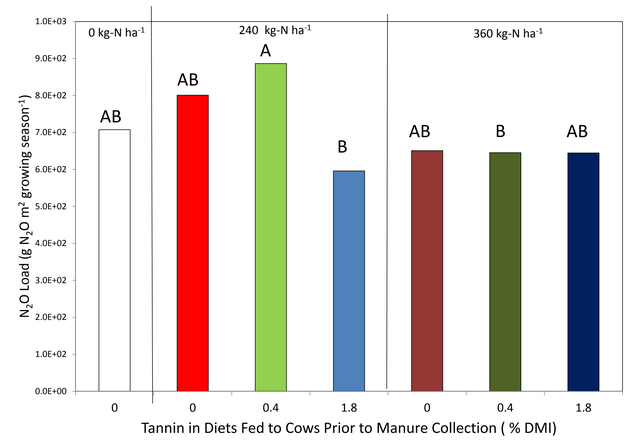
Yield

- There was no significant treatment effect on yield, overall average yield for all treatments was 56.8 Mg ha^{-1} (55% moisture).
- All manure treatments were significantly higher (P<0.05) than control plots.

Manure Storage Prior to Land Application

Manure was collected and stored in large bulk drums, then transferred into five gallon buckets one week before being applied. All manure was handled identically but no storage gas flux measurements were made. Increased volatilization may have occurred during transfer from bulk manure to 5 gallon buckets resulting in lower TN.

Seasonal Emission Load



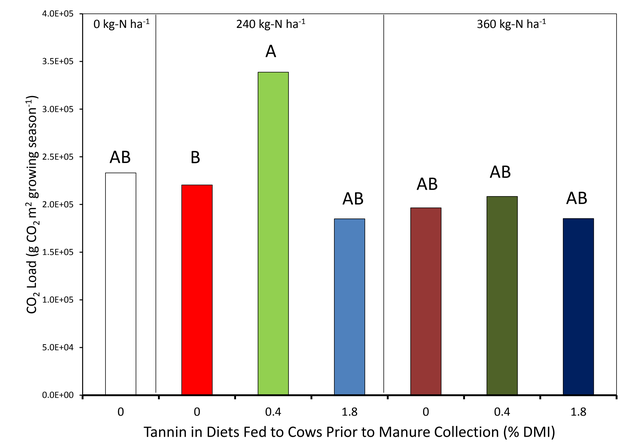


Figure 2. Seasonal emissions load of N_2O and CO_2 as calculated for the entire growing season from manure application to harvest.

Greenhouse Gas Results

- Greenhouse gas fluxes did not show significant treatment differences on any sampling day, but ANOVA results showed significant treatment effects for different gas fluxes.
- Seasonal load through the growing season show that the 0.4 mg tannin diet at 240 kg N ha^{-1} (light green) showed the highest load for both CO_2 and N_2O.

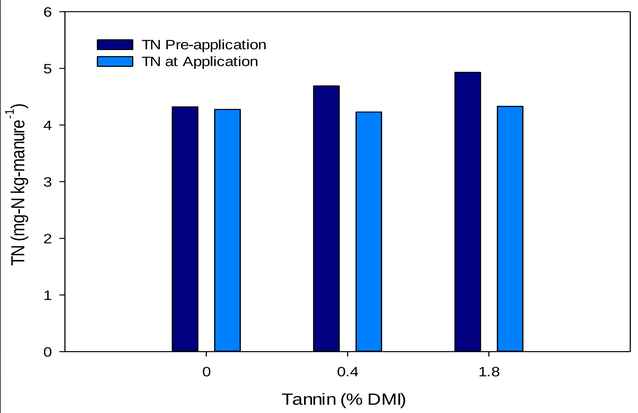


Figure 3. Total Nitrogen in manure shown 30 days before application (dark blue) averaged across bulk storage containers and TN in manure day of application (light blue) averaged across field treatments. TN loss is likely related to ammonia volatilization during storage.