Multi-species cover crop, soil type and fertilizer influence nitrous oxide emissions

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Improving cover cropping and filling knowledge gaps

Problem: Little is known about the effect of mixed stands of winter cover crops on nitrous oxide emissions.

Solution: Find effective methods of cover cropping into corn and soybeans and measure the nitrous oxide emissions during the cover crop and cash crop growing seasons.

Hypotheses

- Interseeding cover crops early will produce greater winter biomass than drilling after harvest.
- Winter N_2O emissions will be highest on plots with more radish biomass.
- N_2O emissions during the cover crop growing season will be lower than N_2O peaks following N fertilization.

Methods:

- Used 2 cover crop experiments:
    - 12 species interseeded into corn (4 brassica, 4 legume, 4 grass)
    - 3 species interseeded into soybeans (1 brassica, 1 legume, 1 grass)
        - Drilled same mix after harvest ~ 5 weeks later
- 4 replicates for each experiment repeated on 2 fields (sandy and silty)
- Harvested cover crop biomass over winter before radishes winterkill
- Gas chambers installed and sampled at times of high expected peaks:
    - Followed GRACEnet protocol
    - Analyzed nitrous oxide on GC with ECD
    - Molar nitrous oxide concentrations determined with ideal gas law:
        - PV=nRT
    - $N_2O-N\ production\ rate = \frac{d(mass\ _2O-N*m^{-2})}{d(minutes\ lid\ on\ chamber)}$
    - Used exponential decay function to calculate cumulative emissions

Figure 1: Two adjacent cover crop treatments showing the head start of interseeding on 3 species experiment. This is one of four reps for this experiment repeated on 2 fields. Image taken 10/24/18

Figure 2: Example gas chamber. Field treatments were laid out at random, but gas chambers were targeted for areas that appeared representative of the treatment and included at least 1 large radish when possible (left). Sampling procedure with syringe in sampling port (right).

How did planting methods affect biomass?

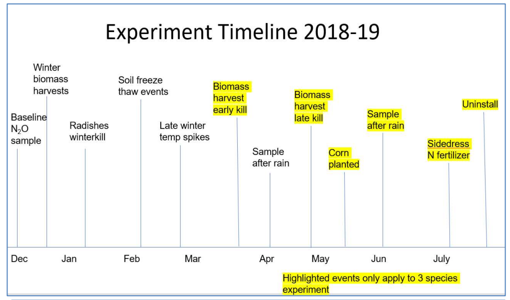

Figure 3: Timeline of the field work performed and major agricultural events. Highlighted events only apply to the 3 species experiment.

Gas chambers were installed in early interseeded and no cover treatment on 4 reps of 2 fields in 12 species experiment. They were also installed in interseeded, drilled, and no cover treatment on 4 reps on 2 fields of 3 species experiment.

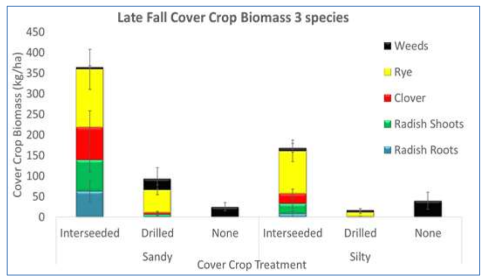

Figure 4: Cover crop biomass from the 3 species experiment harvested in December. Total biomass was significantly higher in interseeded plots and on the sandy field. Error bars represent 1 standard error.

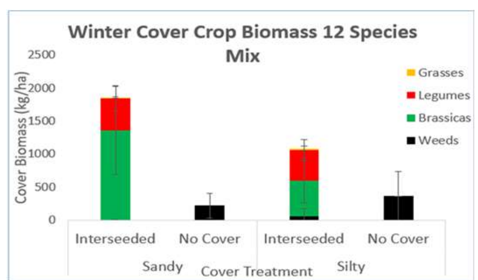

Figure 5: Winter biomass for 12 species interseeded experiment separated by family, treatment, and soil texture. Legume and brassica biomasses were substantially higher than those from 3 species experiment due to early cover seeding date (6/28). Error bars represent one standard error.

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Nitrous oxide emissions by treatment

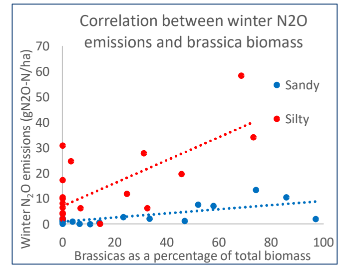

Table 1: Statistics generated from regression trendlines in Figure 6 separated by field.

Stat	Sandy fields	Silty fields
r^2	0.499	0.486
Regression equation	Y=0.0813x + 0.934	Y=0.453x + 7.021
Slope p	0.000634	0.00064

Figure 6: Correlation between the winter N_2O emissions and brassica as a percentage of total biomass separated by soil type from both experiments. Each dot represents the cumulative N_2O emissions between baseline sampling in December and 3/11 from one chamber in one rep. Soil texture was important for producing N_2O and % brassica biomass predicts better than brassica biomass. There was no relationship at low brassica biomass. Soil type significantly increased N_2O emissions and increased the relationship between N_2O emissions and brassica biomass.

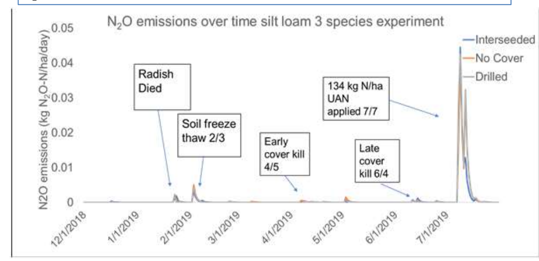

Figure 7: Continuous extrapolation of the N_2O peaks measured over time on the silt loam in the 3 species experiment. Significantly more N_2O emitted following fertilizer application. No differences between treatments.

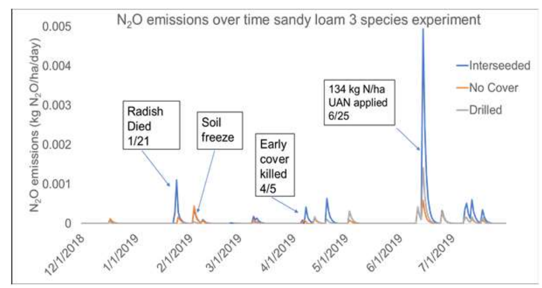

Figure 8: Continuous extrapolation of the N_2O peaks measured over time on the sandy loam in the 3 species experiment. Significantly more N_2O emitted following fertilizer application. No differences between treatments.

Conclusions:

- Fertilizer induced N_2O emissions were substantially higher than the N_2O emissions during the cover crop growing season
- Significantly higher N_2O emissions on silt loam than on sandy loam in 3 species experiment
- Higher N_2O emissions over winter on plots with significantly more radish
- Relationship between N_2O emissions and radish was significant, but small differences in radish biomass did not affect N_2O emissions

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