The Effect of Carbon and Nitrogen Availability on N_2O Production Following Soil Rewetting

Jonathan Vick, Martin Burger, William Horwath

University of California, Davis. Department of Land Air and Water Resources, Davis, CA

INTRODUCTION

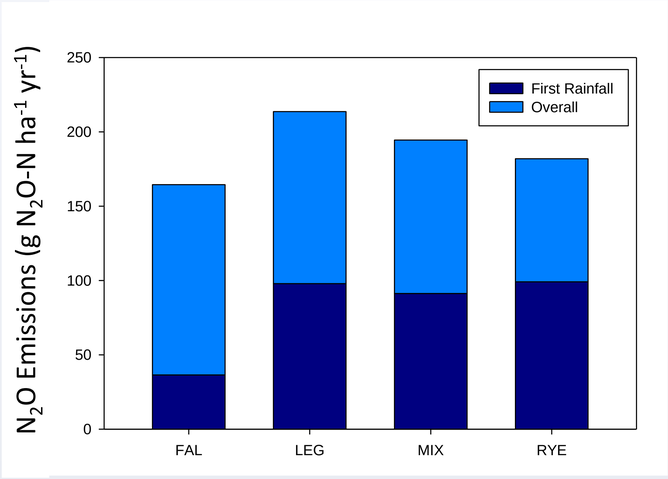

Figure 1: Percent of Overall N_2O Emissions Generated Following First Winter Rains
Labels indicate cover crop treatments in the vineyard alleyway. FAL – fallow, LEG – 50/50 faba bean and field pea mix, MIX - triticale, faba beans, peas, vetch, and mustard.

- Vineyard alley way nitrous oxide (N_2O) monitoring showed that between 25-55% of seasonal N_2O emissions occurred after the initial winter rainfall event after summer dry period.
- Cover crop residues increased N_2O emissions from first rainfall event.
- Carbon (C), nitrogen (N), and oxygen availability have all been shown to affect N_2O emissions.[1]

OBJECTIVES

- Determine if additional N from legume cover crops increase N_2O emissions more than grain cover crop residues,
- Identify mechanistic processes of carbon and nitrate availability on N_2O processes by observing O_2 levels.

EXPERIMENTAL DESIGN

- 3x4 factorial design with 3 levels of nitrate-N addition and 4 levels of glucose-C addition to 15 g soil at 100% WHC (0.265 GWC).
  - 0, 30, 60 mg nitate-N kg^{-1} soil (to background level of 30 mg kg $^{-1}$ soil)
  - 0, 5, 10, 20 mg glucose-C kg^{-1} soil (to background level of 10 mg kg^{-1} soil)
- Gas samples taken at 8hr, 24 hr 48 hr, 72hr, and 96 hr.

RESULTS

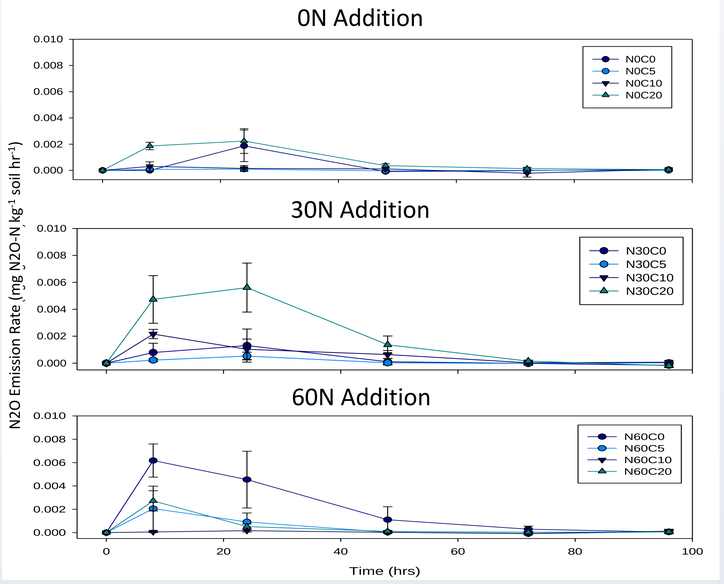

Figure 2: Incubation N_2O emission timecourse
Error bars indicate +/- 1 SE. From the top, graphs indicate 0, 30, and 60 mg nitrate-N kg^{-1} soil additions.

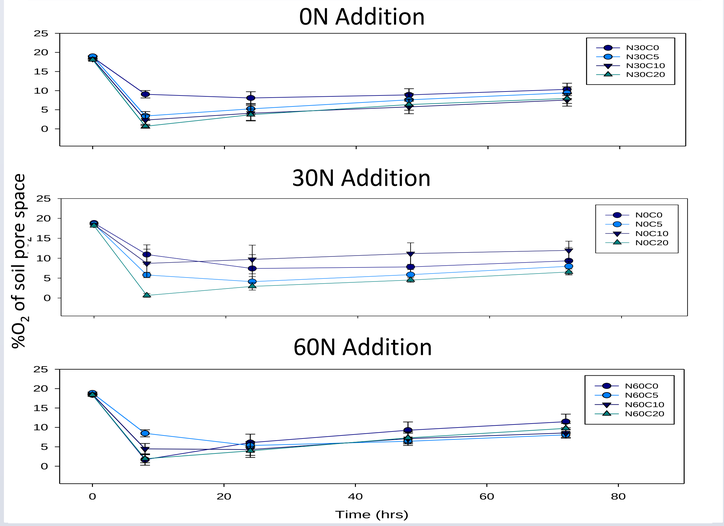

Figure 3: Incubation O_2 emission timecourse
Error bars indicate +/- 1 SE. From the top, graphs indicate 0, 30, and 60 mg nitrate-N kg^{-1} soil additions.

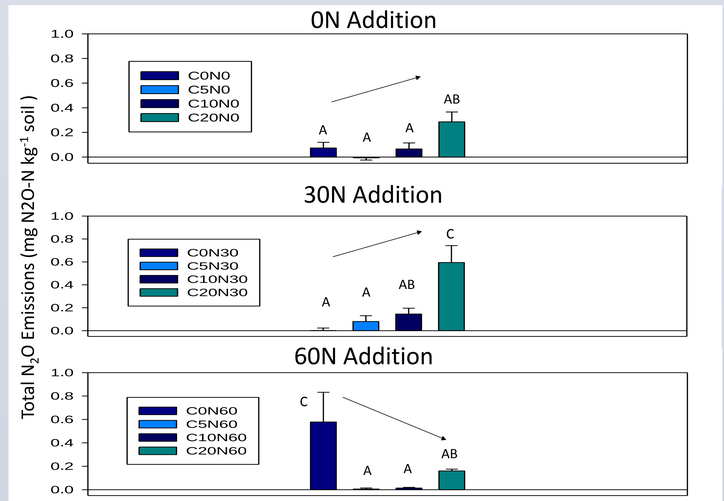

Figure 4: Total N_2O emissions
Error bars indicate +/- 1 SE. From the top, graphs indicate 0, 30, and 60 mg nitrate-N kg^{-1} soil additions. Letters represent Tukey HSD significant differences at the p<0.05 levels across all treatments.

RESULTS (CONTINUED)

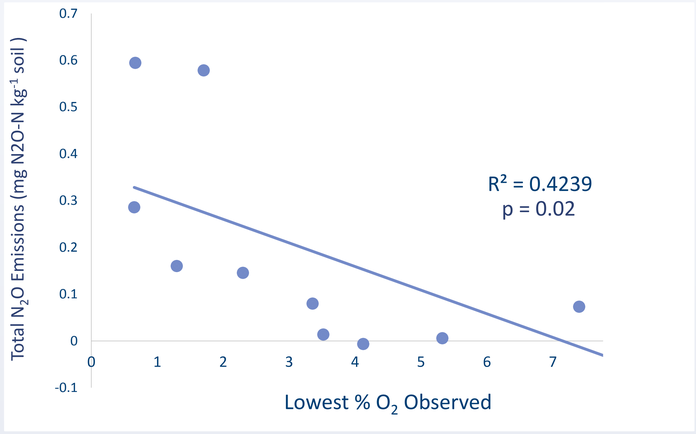

Figure 5: Relationship between Lowest O_2 levels observed and total N_2O Emissions

Table 1: ANOVA results
* indicates significance at the p < 0.05 level,
** indicates significance at the p < 0.01 level.

	SS	F	P
C_add	0.11669	2.3343	0.134049
N_add	0.17143	3.4293	0.071088
$(C\_add)^2$	0.50698	10.1416	0.002731 **
$(N\_add)^2$	0.03611	0.7223	0.400207
C_add*N_add	0.32289	6.4591	0.014819 *
Residuals	2.0996		

DISCUSSION

- The effect of C addition on N_2O emissions varied between different levels of N addition. At low and moderate levels of N addition, C addition increased emissions. However, at high levels of N addition, C addition decreased emissions. This suggests that the C inputs from leguminous cover crops might limit the increase in N_2O generation due to increased N inputs.
- Oxygen levels bottomed out at 8 hrs, creating oxygen limited sites, despite the vials being opened to lab air between measuring points.
- The degree of oxygen consumption exhibited a weak but significant relationship with overall N_2O emissions, suggesting that respiration driven O_2 consumption was an important driver of observed emissions.

WORKS CITED

1. Butterbach-Bahl, K., et al. (2013). "Nitrous oxide emissions from soils: how well do we understand the processes and their controls?" Philos Trans R Soc Lond B Biol Sci **368**(1621): 20130122.

ACKNOWLEDGEMENTS

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CONTACT

Jonathan Vick: jvick@ucdavis.edu