



PROGRESS REPORT

PROJECT TITLE: Climate Change Impacts on Minnesota Corn Production and Environmental Consequences

REPORTING PERIOD: July 31, 2017 to October 31, 2017

PROJECT NUMBER: MN CORN RES & PROMO COUNCIL 4118-14SP & 4118-15SP

PRINCIPAL INVESTIGATOR: Tim Griffis

ORGANIZATION: University of Minnesota

PHONE NUMBER: 612-625-3117

EMAIL: timgriffis@umn.edu

1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (*Describe project progress specific to goals, objectives, and deliverables identified in the project workplan.*)

This report documents the progress of the Mesocosm climate change experiments including the no-cost extension of project 4118-14SP and the continuation of 15SP.

Over the past three months we have focused our efforts on: 1) making improvements in the Mesocosm facility; 2) learning new techniques related to in-situ measurement of denitrification potential; 3) conducting our 3rd experimental growing season; and 4) analyzing the data obtained from the 3rd experimental growing season in the context of our past Mesocosm experiments and field-based observations.

Lee Miller (MS student) is continuing to summarize results from past experiments and is providing near real-time analysis and updates regarding the current experiment. We are developing a manuscript for *Journal of Environmental Quality*. Lee has done an outstanding job conducting in-situ denitrification rate measurements and has summarized to date all of our carbon dioxide and nitrous oxide flux measurements. Lee Miller and technician Matt Erickson are getting ready to examine biomass and yield differences among the experimental treatments. This year's results show that we have significantly improved the biomass accumulation and we expect significantly higher yields compared to our previous experiments. This is most likely a result of our improved LED lighting system.

The photos below show: 1) the initial planting conditions; 2) new LED lighting system; and 3) the corn canopy during the mid-growing season for the 2017 experimental treatment.



2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE.

We are using results from the Mesocosm experiments to help test hypotheses and explain findings from our field-based observations. For instance, our recent work published in the *Proceedings of the National Academy of Sciences* (Griffis et al., 2017, Nitrous oxide emissions are enhanced in a warmer and wetter world, *PNAS*) indicates that nitrous oxide emissions are enhanced during warmer and wetter climatic conditions and that emissions are likely to increase in the future based on projected trends in synthetic nitrogen use and climate. We estimate direct emission factors ranging from 1.3 to 1.6% and indirect emission factors ranging from 1.6 to 3.8% over a six year period. So far, field measurements indicate the overall regional emission factor for the US Corn Belt can be as high as 7%.

Analysis of our recent Mesocosm experiments suggests a direct emission factor of about 2.5%. Thus, using two very different methodologies we suggest that 1.3 to 2.5% of applied synthetic nitrogen is converted to nitrous oxide. Our next goal is to conduct Mesocosm experiments to see if we can reduce the emission factor to less than 1%, which will help us to develop future strategies for dealing with projected increased synthetic nitrogen use and the potential impact of climate change on emissions.

Lee Miller has reanalyzed our previous Mesocosm data using more rigorous statistical analyses and has identified statistically significant differences among some of our climate change treatments. In most cases, the wetter scenarios (wet spring) have favored larger nitrous oxide emissions. This supports that emission factors are likely to increase for wetter climate scenarios, which helps support our recent findings based on field observations. Moving forward it will be important to develop strategies to help lower these emission factors and reduce reactive nitrogen losses.

Our next steps are to determine the Q10 factor (i.e. temperature sensitivity) for nitrous oxide emissions for our control vs experimental treatments.

The impact of our climate change scenario on crop productivity will be assessed over the next two weeks.

3.) CHALLENGES ENCOUNTERED. *(Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project workplan.)*

4.) FINANCIAL INFORMATION *(Describe any budget challenges and provide specific reasons for deviations from the projected project spending.)*

We are currently seeking funding opportunities to keep the mesocosm facility operational through summer 2018. Continuity regarding the technical developments and treatments is critical. At present, we have a USDA proposal pending to help keep the facility operational.

5.) EDUCATION AND OUTREACH ACTIVITIES. *(Describe any conferences, workshops, field days, etc attended, number of contacts at each event, and/or publications developed to disseminate project results.)*

The experiments are being led by MS student (Lee Miller) and PhD candidate (Zichong Chen) in the Land and Atmospheric Science program. Two undergraduate students from ESPM have been hired to help with these experiments.