PROGRESS REPORT

PROJECT TITLE: **Climate Change Impacts on Minnesota Corn Production and Environmental Consequences**
REPORTING PERIOD: May 01 through July 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.*)

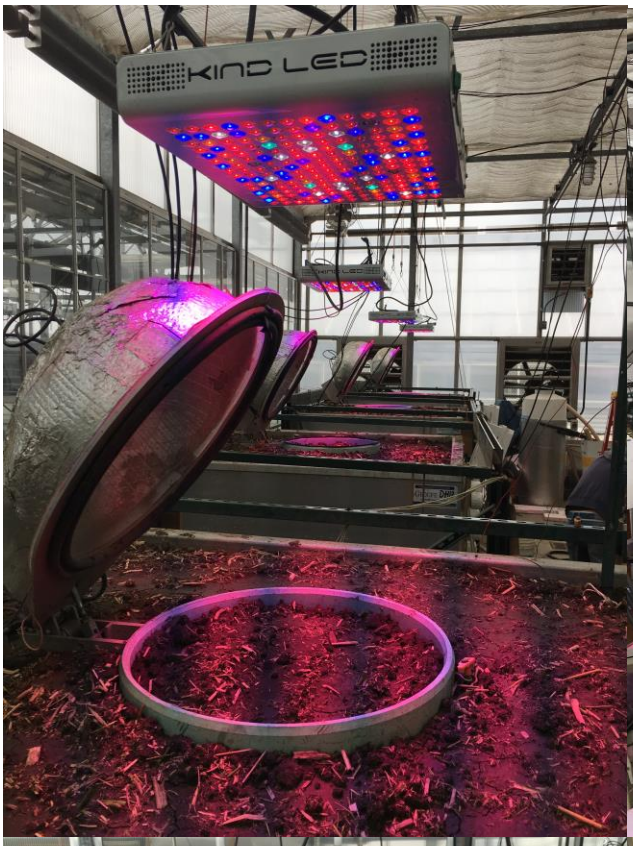
This report documents the progress of the Mesocosm climate change experiments including the no-cost extension of project 4118-14SP and the continuation of 15SP.

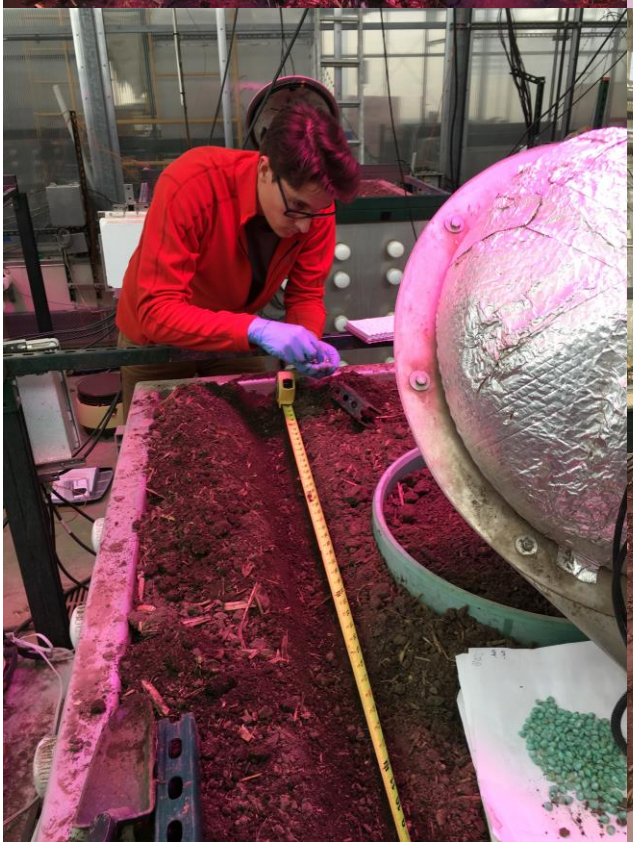
Over the past three months we have focused our efforts on: 1) analyzing and summarizing our past experiments; 2) making improvements in the Mesocosm facility; 3) learning new techniques related to in-situ measurement of denitrification potential; and 4) Initiating our 3rd experimental growing season that will examine the impacts of higher springtime precipitation on nitrogen use/loss and corn production.

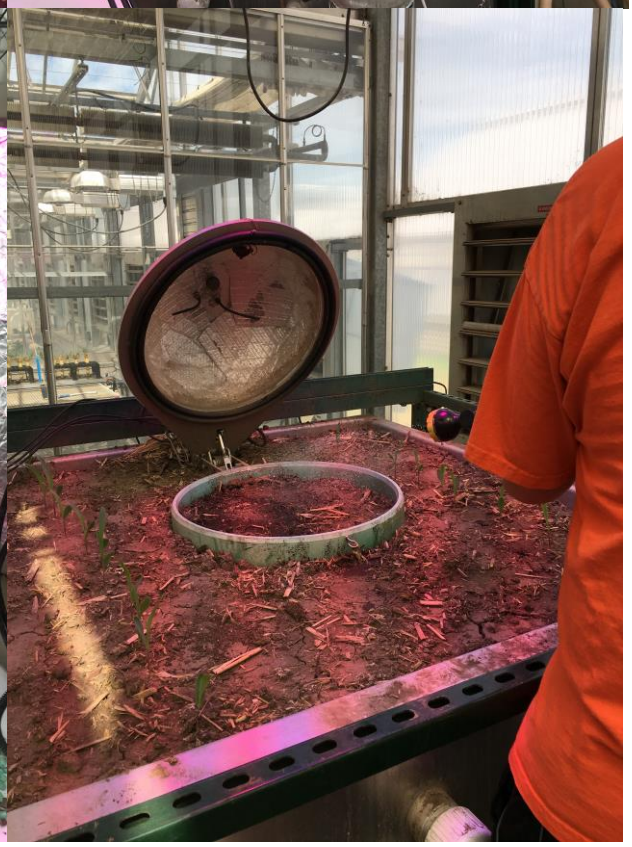
Lee Miller (MS student) is summarizing our past experiments and providing context for our current experiment that was initiated in June, 2017. Our plan is to use these three years of data to publish a manuscript in the *Journal of Environmental Quality*. Lee has been working with Prof. Rod Venterea and Technician Mike Dolan to learn how to make in-situ denitrification rate measurements. He is currently making these measurements each week within experimental (enhanced springtime precipitation) and control (normal climate) mesocosms to help understand differences in nitrogen use and losses and to help interpret our automated chamber nitrous oxide flux measurements.

This summer we have also hired two undergraduate students to help Matt Erickson (Research Scientist) and Lee Miller make improvements to the mesocosm facility and to help with routine measurements and maintenance.

The photos below show: 1) the new LED lighting system and chambers prior to planting corn during the 2017 growing season; 2) Undergraduate student assisting with soil nutrient sampling; 3) Lee Miller planting corn for the 2017 experiment; and 4) Undergraduate student worker watering recently emerged corn plants.


KIND LED





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

Lee Miller has reanalyzed our previous 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 and ammonia emissions. This supports that nitrogen use efficiency will decline in a "warmer and wetter world".

This season's experiment (summer 2017) will add further details to this story. Our preliminary results from early measurements indicate the following (so far).

We have been taking bi-weekly soil samples and have been running a set of soil extractions to measure nitrate, nitrite, and ammonium. Nitrate and nitrate which play an important role for nitrous oxide emissions have shown the same trend as nitrification potential with increases in concentration over the first 3-4 weeks and then a decline in concentrations. The drop off in nitrite concentration is much more precipitous than the decline in nitrate. These two measures should help give us an idea how nitrogen is moving through the soil. Nitrate concentrations, and incidentally nitrite concentrations, differ between chambers even though they all received the same level of fertilizer. Initial concentrations started around 5mg N/L for nitrate and increased upwards of 20 mg N/L, and started around 0.03 mgN/L for nitrite and increased upwards of 0.25 mgN/L. Nitrite is much more transient than nitrate.

The DEA (denitrifying enzyme assay) analyses have shown some agreement with the measured nitrous oxide fluxes. There has been an overall trend of increasing denitrification potential for the first four weeks of the experiment and then a decline in potential. There is considerable variability among the mesocosms, and a couple of hot spot moments of very high denitrification potential. Denitrification potential, measured in ng N/g/hr had an initial range of about 115 and increased up to 150 with peaks and hot spot moments ranging from 270 to 487. Denitrification potential decreased below 100 for most mesocosms by about week 6.

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.*)

There have been no budgetary challenges or deviations from projected project spending. In November 2016 we were awarded a National Science Foundation (NSF) grant to examine regional ammonia emissions based on our tall tower measurement program. There will be synergy between this new NSF grant and the measurements taking place at the mesocosm facility. Together, the research will help us better understand how management and climate impact reactive nitrogen loss to waterways and the atmosphere. Further, we have submitted a new proposal to USDA to provide further support for our reactive nitrogen research.

5.) EDUCATION AND OUTREACH ACTIVITES. *(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 this summer's experiments.