**Effects of CO2 Enrichment on the Responses of Legume-Rhizobia Symbiosis to Elevated Soil Temperature**

Audrey Corcoran, Caleb Lee, Siyuan Du

Both planetary temperature and atmospheric carbon dioxide concentration are expected to increase in the coming decades, and to have significant effects on the growth of development of plants (IPCC 2014). *Pisum sativum* is a food crop that will likely continue to be grown and depended upon in future and will therefore be affected by these factors and the interaction between them. We are doing a two-factor study on the effects of CO2 concentration on the response of *P. sativum* and its *Rhizobia* symbionts to soil temperature. Previous studies have found that elevated soil temperature alone increases root respiration but inhibits nodulation and nodule activity; elevated CO2 alone enhances short-term plant growth and nodule abundance; and a combination of elevated temperature and elevated CO2 generally enhances legume growth (Lira et al 2005, Phillips et al 1976, Wang et al 2012). Based in part on these findings, we hypothesize that elevated CO2 will benefit the plant by allowing it to perform photosynthesis more quickly and efficiently, while elevated temperature will inhibit plant growth and nodule performances; however, CO2 will also benefit the *Rhizobia* by providing it more photosynthate, counteracting to some degree the potential negative effects of elevated temperature on nodulation. We set up four groups with six plants in each group: ambient CO2 and temperature, ambient CO2 and elevated temperature, elevated CO2 and ambient temperature, and elevated CO2 and temperature. We predict that the elevated CO2, elevated temperature group will have greater biomass, root proportion, nodule quantity and lower C:N ratio than the ambient CO2, elevated soil temperature group. Our results may help elucidate the future of *P. sativum* grown agriculturally as it is exposed to steady increases in both temperature and CO2 concentration.

**Effects of N-enriched leaf litter and decreased temperatures on *Aedes aegypti* mosquito larvae**

**development time and biomass**

Brandon DeBella, Hye Sun Kim, Olek Yardas

Current trends of increasing global CO2 levels and average global temperatures will have significant effects on organisms. For aquatic organisms more so than terrestrial ones, the effects will possibly be more severe due to comparatively quick homogenization of environmental effects over time. Mosquitos are one such organism which the effects of such changes in the climate will have a significant effect on. Also, mosquitos are responsible for millions of deaths annually, and due to this it is vital that the response of increased atmospheric CO2 and temperature is known. Mosquito larvae are cosmopolitan aquatic detritivores who feed on leaf litter and aquatic microorganisms. The effect of increasing CO2 on plants is known to increase the C:N ratio via increased photosynthetic carbon fixation. This has an effect on leaf litter decomposition due to the decreased microbial presence on and in the leaf litter. We intend to pursue the question of the effect of feeding leaf litter of different C:N ratios on the development time of *Aedes aegypti* larvae in different temperatures.

**Effects of elevated Air and Soil Temperature on Above and Below Ground Biomass**

**and Extent of Nodulation of the *Phaseolus vulgaris* and *Rhizobia*.**

Kyle Buse, Brian Haggard, Lynn Nguyen

*Phaseolus vulgaris* is a crop belonging to the legume family, known for its symbiosis with the *Rhizobia* bacteria. This relationship is mutualistic as the plant provides nutrients for the bacteria to grow and the bacteria in turn fix atmospheric nitrogen into usable nutrients for the plant to grow (Beringer et al 1979). Previous research offers opposing effects of elevated temperatures on legume growth. Whittington et al 2013 suggest that plants grown in higher air temperatures will exhibit more aboveground growth in the form of increased shoot biomass and Beringer et al 1979 suggest that plants grown in higher soil temperatures will increase *Rhizobial* efficiency, increasing root nodule growth and nitrogen fixation, therefore increasing plant growth. Contrarily, McDonald et al 1997 found that increasing temperatures negatively affects photosynthesis and growth. We seek to further explore the interplay between changing air and soil temperatures and their effect on legume-*Rhizobia* symbioses, measured by legume growth, through observing *Rhizobia* inoculated *P. vulgaris* growth under four scenarios of ambient/elevated air and ambient/elevated soil temperatures. We will set up a 2x2 design with two greenhouse bays at an ambient and an increased temperature and with a heat mat under 12 seeds in each bay to increase soil temperature. We hypothesize that an increase in air temperature, both with and without an increase in soil temperature, will be detrimental for the legumes and therefore result in reduced growth (biomass). *P. vulgaris* and *Rhizobia* symbioses are significant in global agriculture due to the food they supply, along with their role in soil re-enrichment.

**Different soil temperatures and levels of atmospheric CO2 affect total biomass of *Zea may*s and *Glycine ma*x**

Raghu Inturi, Fengming Li, Carmen Ribadeneira

Previous studies have found that the growth of corn and soybeans, the two most important crops in America, are affected by changes in soil temperature and atmospheric CO2. Leakey et al. found that increased CO2 has a positive effect on corn production and Abebe et al. observed the negative relationship between higher than optimal temperature and corn production. Long et al. found that an increase in CO2 will offset the negative effects of increased temperature, and that corn and soybeans will react differently to the different environments. Nevertheless, no experiment has been done that directly compares different levels of CO2 and soil temperature to corn and soybean growth. We test to see how four different combinations of atmospheric CO2 levels and soil temperatures affect the total biomass of *Zea may*s and *Glycine ma*x. We grew 12 cells of both *Zea may*s and *Glycine ma*x in each of the four environments for four weeks. The four groups were placed under four different combinations of ambient and elevated soil temperatures and ambient and elevated CO2 conditions with the control being ambient soil temperature and ambient CO2. We predict that C3 plants (soybeans) and C4 plants (corn) will show a similar trend in the same environment but not to the same degree. We predicted that the AT ECO2 (Ambient Temperature Elevated CO2) group will exhibit the largest biomass results, the ET ECO2 (Elevated Temperature Elevated CO2 ) group will be second, the AT ACO2 (Ambient Temperature Ambient CO2) group (control) will be third, and the ET ACO2 (Elevated Temperature Ambient CO2) group will exhibit smaller biomass results than the control group. The changes is biomass as a result of climate change may impact US economy, food production, and farming laws and subsidies.

**The effects of rising temperatures on competition between *Microcystis* and *Chlamydomonas***

Chris Roberts, Erika Bayne, Mayu Sakae

Due to the increase in temperature, the waters of Iowa are plagued by harmful algal blooms. Cyanobacteria, such as *Microcystis aeruginosa*, are prevalent in bodies of freshwater and can also be a harmful source of contamination for humans. In this study we will look at how *Microcystis* and *Chlamydomonas* are impacted in competition by a changing temperature. The two treatment groups were put in a 22 C chamber with half the cultures on a ehating element at 29 C, we placed three different types of cultures in 125 mL Erlenmeyer flasks: *Microcystis*, *Chlamydomonas*, and *Microcystis* and *Chlamydomonas* all placed in mixture of Bold’s basic medium and soil water to see how temperature affects their indivudual growth and competition. Previous studies have shown that both the cyanobacterial and algal blooms will intensify, but chlorophytes will be more successful in the changing climate (Lurling et al., 2013). In another study, *Microcystis aeruginosa* exhibited a strong competitive inhibitory relationship with a different species of green algae, with the green algae inhibiting the cyanobacteria (Zhang et al. 2012). Thus we hypothesize that green algae population will be the stronger competitor in terms of population count over the cyanobacteria.

**The Interaction Between *Fusarium oxysporum* and Soil Temperature on *Glycine max*Soybeans*.***

Valencia Alvarez, Sayles Kasten, Hannah Lundberg

Climate change is a serious ecological threat to both natural and agricultural environments. This study focuses on the agricultural side, specifically the interaction between fungal pathogens and agricultural crops. Fungal pathogens represent a significant detriment to agricultural yield worldwide. We chose to study the combined effect of soil temperature and the fungus*Fusarium oxysporum*on *Glycine max*soybeans to consider how climate change could interact with fungal pathogens to affect plant growth, using soil temperature as the climatic variable that would impact this pathogen that impacts root growth in a wide variety of staple crops. We performed a four factor experiment, with the independent variables soil temperature (29.7 C and 35.3 C) and fungal inoculation. Seeds were inoculated at a height of around 9 cm with a razor blade at the base of the stem. Seedlings remained infected for sixteen days, after which their total plant biomass and root biomass were measured to asses the effect of the independent variables. To analyze our results, we ran a 2-way ANOVA test. We expect that the inoculated seedlings in the warmer soil will be most affected by the *F. oxysporum*, and that plants in the ambient environment will be affected less significantly. In addition to generally improving human understanding of the details of climate change, the results of our experiment will be directly relevant to farmers, agriculture companies, and investors involved in growing soybeans, and more tangentially related to those parties involved in growing other crops impacted by strains of *Fusarium*.

**The Effect of Nitrogen and Phosphorus Enrichment on *Synedra* and *Microcystis* Abundance**

**and Population Composition**

Anna Bell Hines, Ben Hoekstra, Khoi Luu

Climate change is expected to promote the frequency and severity of extreme precipitation events and thereby threatens to increase nutrient leaching in agricultural areas. In the American Midwest, these precipitation events and floods traditionally occur in the spring and summer months--the same time as peak fertilizer application. This nutrient supplementation to surface waters promotes the explosive growth of microbes and can impair the ecological health of waterways. Motivated by this threat of eutrophication, our study will investigate the impact of nutrient supplementation on the abundance and population dynamics of the cyanobacteria *Microcystis* and the diatom *Synedra*. Mixed cultures of *Microcystis* and *Synedra* are inoculated in growth media and subject to a 2-factorial manipulation of nitrate and phosphate salt levels. One group receives no additional nutrients, one group is nitrate supplemented, one group is orthophosphate supplemented, and one group receives both N and P supplementation. We predict P to be a more limiting input than N due to the ability of *Microcystis* to fix atmospheric nitrogen and therefore expect the P-enriched group to experience a greater abundance response than the N-enriched group. The excess of both nutrients in the NP-enriched group leads us to believe NP will have the greatest abundance response. Previous work suggests that N-fixing cyanobacteria are favored under N-limited conditions while those phytoplankton which cannot fix N are favored when N is in abundance (Goleski et al. 2009, Smith 1990). We therefore expect populations of *Microcystis* to dominate in the P-enriched group and, correspondingly, for *Synedra* to dominate in the N-enriched group. The summed biomass of both phytoplankton species will be approximated by chlorophyll-a fluorometry. Population composition will be estimated by cell counts of homogenized aliquots of terminated cultures. A two-factor ANOVA analysis will test chlorophyll-a and cell count response to N supplementation, P supplementation, and their interactions.

**Do the cold and dry affect respiration of earthworm *Lumbricus terrestris?***

Loery, Maggie, Ngo, Nhi

Earthworms such as *Lumbricus terrestris* have invaded parts of the northern US from its warmer natural habitat in Europe. Although it is a common belief that earthworms are good for their environments, the truth is that invasive earthworms have significantly damaged soil environments (Eisenhauer, Stefanski, Fisichelli, et al, 2014). While other experiments have looked at the effect of warmer than optimal temperatures on the respiration rate of *L. terrestris* worms, we want to look at the significance of colder than optimal temperatures on the respiration of *L. terrestris* worms. Another point of investigation involves soil water content. Earthworms depend greatly on soil moisture to keep their own skin moist, as it needs to be for oxygen to pass through it. Climate change has varying effects on soil water content: while warming temperatures lead to decreased soil water content, climate change is also associated with the greater occurrence of extreme precipitation events, which would naturally increase soil water content. Therefore, we want to investigate the effect soil moisture levels both higher and lower than *L. terrestris* usually lives in on its respiration. We hope to find whether colder and drier soil conditions significantly decrease *L. terrestris* respiration, which would minimize the damage done as lower respiration indicates lower activity. In extreme cases, it would be possible for the worms to desicate: in this case we would find the environmental limitations of *L. terrestris*, and therefore would become better able to predict what areas of the northern US it is capable of colonizing. We hope overall to gain better predictive power for not only where worms such as *L. terrestris* are capable of colonizing, but what the level of damage they would be likely to cause once they have colonized.