Kearney Foundation Fellowship
Final Report Summary

Fellowship Recipient's Name: Ida Fischer

Project Title: Studying the affects of geologic N on carbon cycling
Mentor Professor's Name: Dr. Ben Houlton

Reporting Period: Summer 2009

Background and Project Objectives:

Ecosystems are dynamic networks which are largely influenced by nutrient cycling. Understanding nutrient movement between rocks, soils and plants can increase understanding of soil fertility as well as individual health and productivity within that ecosystem. Plant development is effected by nutrient availability. Currently the Houlton Lab group is examining the effects of bedrock sources of nitrogen on nutrient cycling and limitation across an array of California ecosystems.

Thus far Houlton Lab Group has observed that geologic N has a positive nutrient affect on *Pinus ponderos*a in the Klamath Mountains. By attempting to reproduce observed patterns from the field under known conditions this pot study is an attempt to experimentally isolate the effects of rock N on plant growth patterns. This project seeks to understand the nature and extent of geologic nitrogen as a significant source of nitrogen for plants.

Root to shoot ratios will reveal differences in nutrient availability and absorption, as these ratios incorporate patterns of carbon allocation in response to changes in nutrient cycling. This has been demonstrated in previous research which shows in N limited plants allocate C resources to roots as opposed to shoots. This increased root surface area aids in nutrient uptake, as roots begin exploring soil microsites for nutrients to boost gains in productivity. Therefore plants receiving nutrient benefit from Geo N should reflect this absorption in their root to shoot ratios.

Project Design and Status

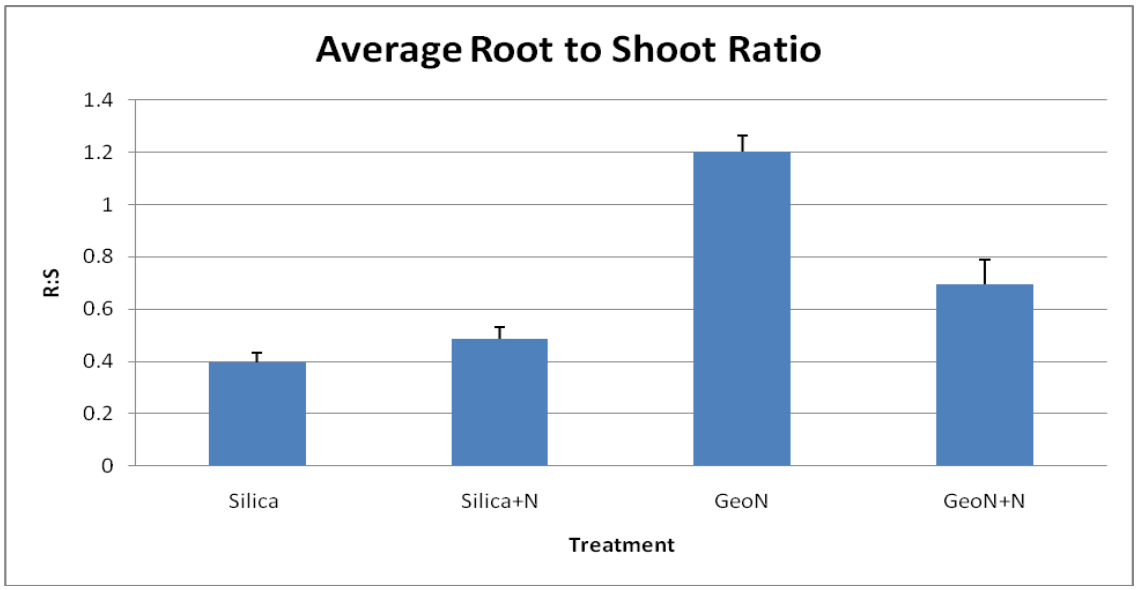
The experiment used *Bromus carinatus* in a standard pot study. The pot study was conducted in a growth chamber of controlled temperature and light. There were two different growth medias, and two different treatments combined to make four different types of pots: silica, silica with inorganic nitrogen fertilizer, silica mixed with an N rich saprolite (referred to as Geo N), and silica mixed with an N rich saprolite with inorganic nitrogen fertilizer. There was a total of 48 pots, twelve of each pot type, however not all the pots germinated. The watering solution was a modified Hoagland solution composed of $Ca(H_2PO_4)_2$, $CaSO_4$, K_2SO_4, $MgSO_4$, Na_2MoO_4, which is later diluted to a half strength solution and was again modified with the $CaSO_4$ removed. The fertilizer was applied 3 times on August 8th, September 9th and October 7th at a ratio of 200 kg/ha. The heights were measured several times throughout the experiment to track growth rates. After 74 days the plants were pulled, dried and massed to determine root to shoot ratios. We are still in the process of calculating the mass of nutrients applied to the plant through solution. If there is enough sample mass further chemical analyses may be used on the samples to determine nutrient level in the biomass.

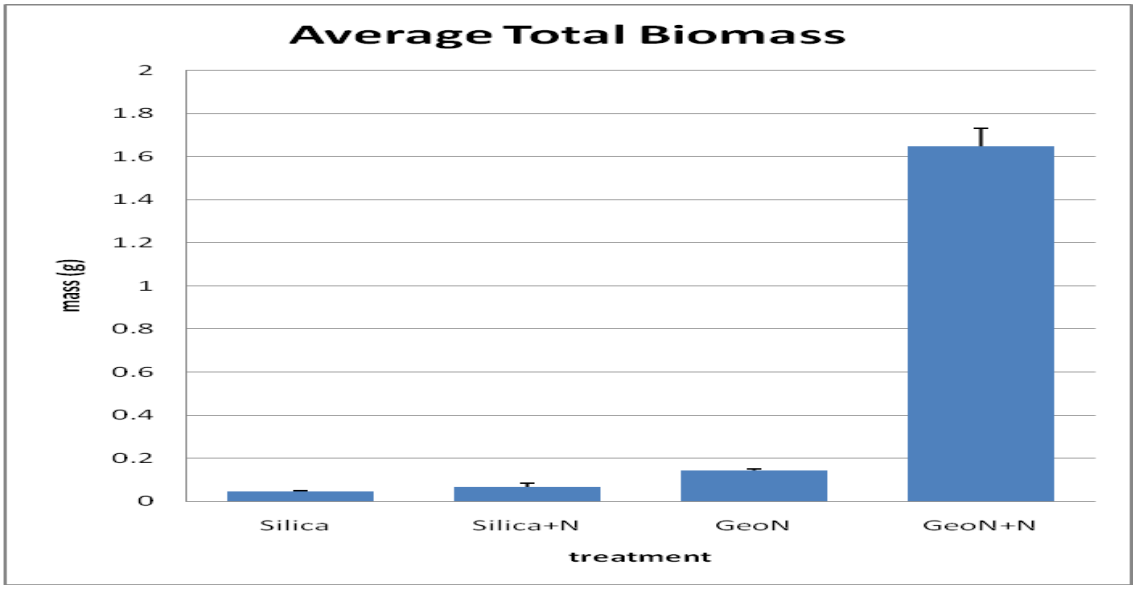
Challenges:

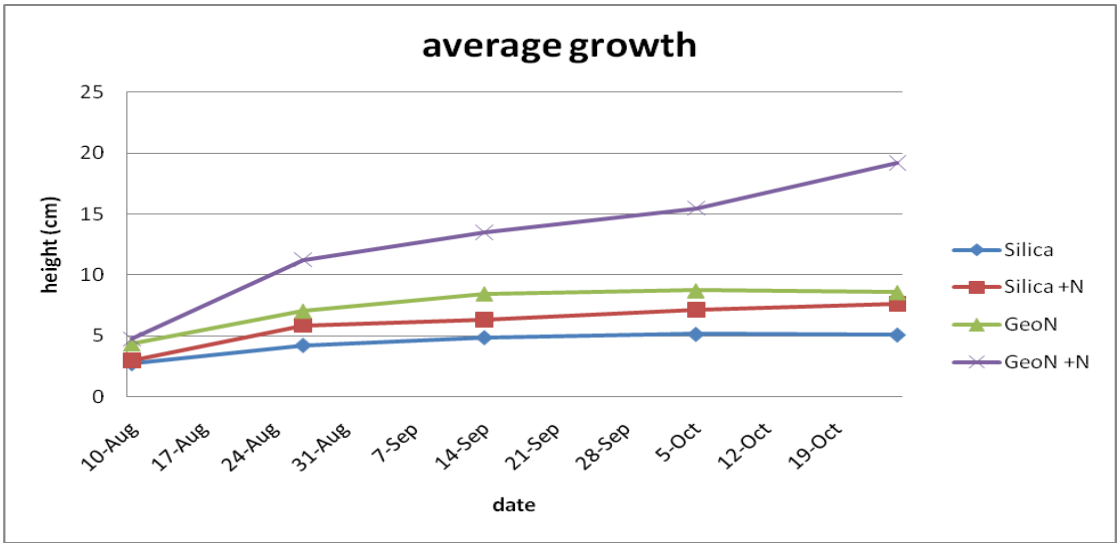
The watering solution proved the most difficult part of the experiment. Creating a watering schedule was challenging as it is important that they have enough moisture, but also critical that the pots were not overwatered resulting in runoff as that would have interfered with nutrient budgeting. Some of the substrate settled out of the nutrient solution and it was difficult to thoroughly mix the solution; therefore the nutrients in solution were not in constant concentration when the solution was applied to the plants, this may result in inaccurate nutrient budgets. The actual composition of the watering solution also proved problematic- as it was important to provide the plants with necessary nutrients in appropriate amounts. There is some possibility that the nutrient solution was not balanced and other nutrient limitation besides nitrogen or carbon effected plant growth. Massing the roots and shoots was challenging as the mass was small enough to require a microbalance but the samples were large enough that an accurate weighing was difficult to accomplish. At first samples were weighed in envelopes and then the sample mass was found by difference. This was problematic when some samples came up with negative mass so all the samples were reweighed in tared weigh-boats.

Results:

Throughout the course of the experiment the saprolite with the nitrogen fertilizer displayed the greatest height, the plain saprolite had the second greatest average height, followed by the silica with nitrogen fertilizer and the plain silica were the shortest plants. Total biomass followed the same trend, with Geo N with nitrogen fertilizer producing the greatest biomass, then Geo N, followed by silica with nitrogen fertilizer and straight silica with the least biomass. When it came to root to shoot ratios Geo N had the greatest, next was Geo N with nitrogen fertilizer, then silica with nitrogen fertilizer and finally silica. Although the higher root to shoot ratios on the pots with Geo N seemed surprising given that increased nutrient availability should result in lower root to shoot ratios, it could be that since the plant was receiving a nutrient benefit from mining the soil and therefore continued investing biomass below ground. This is supported in that both the plain Geo N and the Geo N with nitrogen fertilizer displayed higher ratios since the Geo N with fertilizer was receiving nitrogen in the fertilizer and therefore was not as N limited. Also given pots of Geo N and Geo N with fertilizer, mass and growth patterns they received some benefit from the soil.







Opportunities:

Given that there were only four different types of pots there is a lot of room for more variation in the study. To more fully appreciate the difference the Geo N is making it would be helpful to have more pots with a greater variety of known nitrogen fertilization. Perhaps there could be a two or three types of pots receiving an increased amount of nitrogen so there could be more variation in plant response. Adding a phosphorous fertilizer would also enrich this study as nitrogen and phosphorus cycles are closely tied. There are many ways this study could be expanded to give a more precise picture of the impact that Geo N is having on plants, however for a beginning experiment it was successful in determining that Geo N does have a noticeable impact on plant growth.