Summary Report
2011–12 TWRI Mills Scholarship Program

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Introduction

The research this scholarship helped fund was conducted in the southeast Houston area. Four semi-intensive green roofs were investigated for their water and soil quality. All four green roofs are constructed the same and are within a few miles from one another. The unique aspect about these green roofs is that they harvest and recycle rainwater to be used for irrigating the green roof. Very few systems in the United States contain both a green roof and rainwater harvesting. Each building collects rainwater from the roof and the parking lot and stores this water in underground holding tanks. This water is then used to irrigate the roof as well as each building's surrounding landscape. Efficient use of our fresh water is necessary to keep up with the growing demands brought about by increasing population. Research that investigates methods to improve our efficiency and sustainability of our fresh water is vitally important. My investigation includes testing the irrigation (which is coming from the holding tank), runoff (which has been applied as irrigation and passed through the green roof's media), and soil samples. A green roof that receives no irrigation but rainwater only as well as a conventional roof are both being compared as well. The data from the conventional roof will mostly be used for runoff quality comparison and is not the major focus of the project. I hypothesize that the continuous recycling of water through the system will lead to an increase in salt and nutrient concentration. High concentrations of salts and nutrients in the system can lead to soil and plant problems thereby affecting the efficiency and function of the green roof. This type of research is important in determining how green roofs can be incorporated to help improve urban areas and their impact on affected ecosystems.

Research and Findings

All four of the roofs vary in age from 2.5 years to 6 years of age and are constructed very similar with a few differences in plant species. I expect that the differences in the ages of the roofs can help give some clue as to the trend that is happening with the soil and water chemistry through time. Sample collection began in July 2011 and will conclude in October 2012. Water and soil samples are taken during bi-monthly trips to the roofs and brought back to the Nutrient and Water Analysis Laboratory at the Texas A&M University campus (Soil and Crop Science Department,

Texas A&M University, 2474 TAMU, 621 Heep Center, College Station, TX 77845-2474). The parameters of interest are nitrate, phosphate, potassium, calcium, magnesium, sodium, pH, EC, dissolved organic carbon and nitrogen. The soil samples include all the previous parameters as well as percent organic matter. A full and detailed analysis has not yet been conducted. All samples that have been collected have already been processed and entered into my database and are awaiting data analysis. I have, however, done a preliminary analysis from the samples collected from July 2011 – February 2012 which I presented at the Texas A&M University Student Research Week 2012. It appears that all four of the green roofs are behaving very similar regardless of age. I expected the oldest roof, and its water system, to contain the highest concentration of nutrients and salts in its water and soil (Figure 1). Sodium is in the highest concentration among most of the roofs' soil extracts and next to highest concentration of each roof's runoff. However, there is no observable trend in roof age. The calculated sodium adsorption ratio (SAR) never exceeds 2 in the water samples or the soil extracts (Figure 2).

Figure 1 Nutrient concentrations of (a) soil extracts and (b) runoff/leachate. Roofs are in order of increasing age (left to right). Roofs are increasing in age from left to right. There is no relationship between roof age and nutrient concentration.

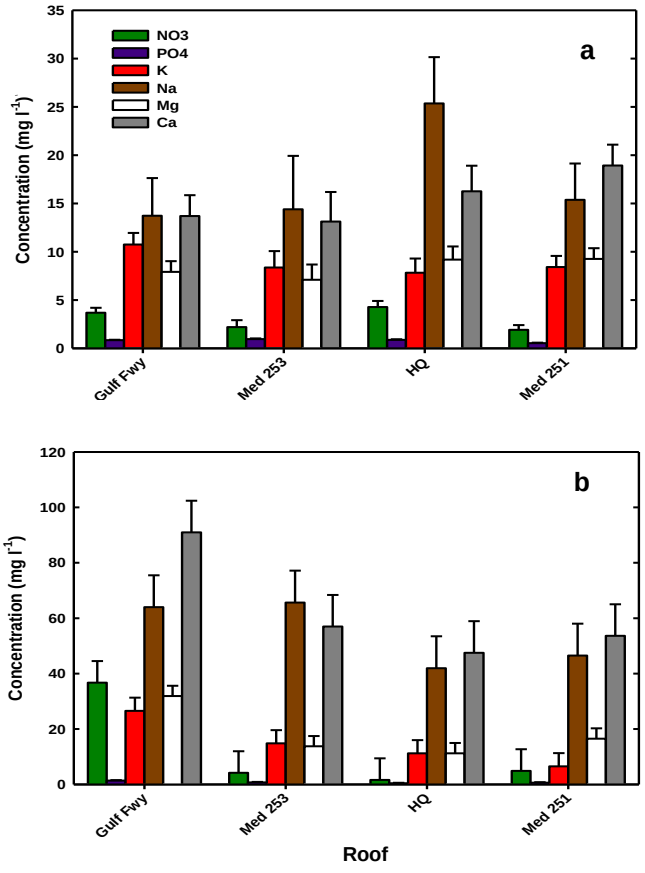
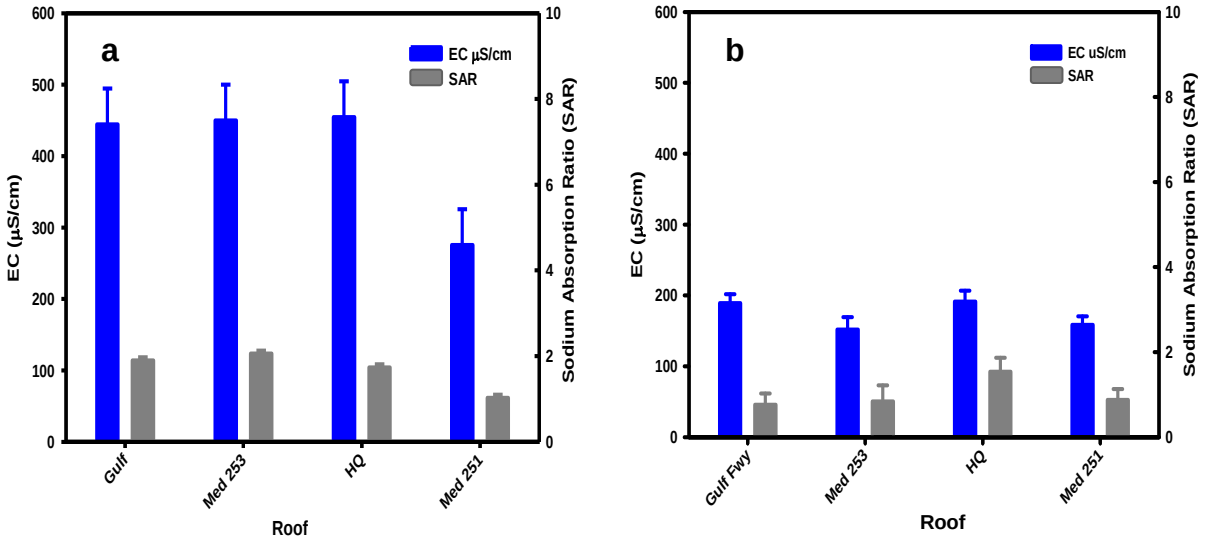


Figure 2 Electrical conductivity and sodium adsorption ratio (SAR) of irrigation water (a) and soil extracts (b). Roofs are in order of increasing age from left to right. There is no relationship between roof age and EC or SAR



While the sodium concentrations in the soil extracts and runoff are in relatively high concentrations compared to the other nutrients, the low SAR value indicates that there is sufficient calcium and magnesium to negate the negative effects of high sodium concentrations. Sodium adsorption ratio and EC are higher in the irrigation water than the soil extracts (Figure 2) and the runoff/leachate is higher in nutrient concentrations that the soil extracts (Figure 1). This suggests that the soil is not witnessing much, or any, of a build-up of salts and nutrients within the soil profile. All four green roofs have an average media depth of 15-18cm. This shallow profile might help explain why the soil is not exhibiting an increase of nutrients. Water is quickly percolating through the soil and into the holding tanks where it sits until it is applied as irrigation. While EC and SAR are higher in the irrigation it does not appear to be concentrated enough to create a problem for the soil and plants on the roof. A possible explanation might be that enough rain is collecting into the holding tanks to dilute the mixture to the resulting low concentrations. However, this data was taken from samples collected during a severe drought in the latter half of 2011. Even with little rainfall to dilute the holding tanks, the SAR did not appear to create an issue for the system.

Continued Work

A final collection of samples is scheduled for October 2012 after which they will all be processed in the lab. A complete analysis will be conducted during the fall 2012 semester and continued into the spring. Another portion of this project is conducting gas exchange (photosynthesis) and water potential measurements of the plants on the roofs (using a Li-cor and pressure chamber, respectively). This will help gain insight into plant function and production and indicate if the plants are stressed and if so to what extent. Runoff samples from a conventional roof are also being compared to runoff samples from the green roofs for quality comparison.