Plant-microbe mechanisms & responses to environmental stressors on urban green roofs

Introduction
Extreme climate events such as heatwaves and droughts are predicted to increase in frequency in the northeastern United States. Building green infrastructure such as green roofs is a way for cities to mitigate environmental stressors but these living systems will also be affected by extreme climate variation. The response of green roof plants to heat and drought is not well-documented and the effect of soil microbial communities on these plant responses is entirely unknown. Beneficial root-associated microbes, including arbuscular mycorrhizal (AM) fungi, which aid host plants under heat and drought stress, have been confirmed on urban green roofs. Understanding the response of green roof plants, microbes, and plant-microbe interactions to heat and drought is crucial for future urban climate change resiliency planning.

Project goals
This project seeks to characterize how different combinations of green roof plant species (Panicum virgatum, Solidago nemoralis, Sedum tetractinum) and root-associated microbial assemblages respond to isolated and simultaneous heat and drought treatments.

Hypotheses
(1) Plants inoculated with green roof soil will have greater percent root colonized with AM fungi than control pots
(2) Plants with AM fungal associations will have increased stomatal conductance ($g_{st}$) across a range of environmental conditions

Methods
(1) Experimental design: We explore how plant-water relations are partitioned by soil type and environmental treatment. Soil microbial communities were established in greenhouse pots via inoculation with field-collected soil from conventional green roofs planted with Sedum and green roofs planted with mixed vegetation, and with green roof media autoclaved as a control. Plants undergo heat and drought treatments for one week.
(2) Plant Ecophysiology: stomatal conductance ($g_{st}$) and chlorophyll fluorescence will be measured to evaluate transpiration rates and plant stress. This will occur four days preceding, one week during, and four days after the treatments.

Preliminary results
Between 10am-1pm, $g_{st}$ was measured on a subset of plants one and two days after watering. S. nemoralis had the highest $g_{st}$ followed by P. virgatum and S. tetractinum ($p<0.001$). All plant species had reduced $g_{st}$ from day one to day two ($p<0.05$). Soil type was not significantly correlated with $g_{st}$ by day or by species. However, gs for S. tetractinum on day two was correlated with soil type ($p<0.05$). Additionally, $g_{st}$ was more strongly correlated with $g_{st}$ for day two versus day one.

Impact
This project will allow us to explore green roof biotic community dynamics and their response to climatic events information regarding how soil microbial communities, including functional groups such as AM fungi, respond to environmental conditions and subsequently influence plant ecophysiology, could contribute to urban climate change resiliency planning. We hope that this project will inform green roof management in the future.

Figure 1B: Example of a conventional green roof planted with Sedum (Javits Center)
Figure 1A: Green roofs in NYC used as sites for field-collected inoculum. Red points indicate Sedum green roofs and blue points indicate roofs with mixed vegetation.

Literature cited

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