Effect of Drought Conditions on Microbial Communities in Native Rangelands

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Introduction

Climate change is a result of greenhouse gases released into the atmosphere. These changes are expected to cause extreme weather conditions, including severe storms. Large amounts of rain will fall in shorter periods of time, leading to heavy runoff, and increasing the severity of drought conditions within the soil (Zeglin et al. 2013).

Native grasslands occupy almost a quarter of the earth's land surface and are valuable ecological resources. They contain soils with high concentrations of organic matter and play a key role in helping to mitigate greenhouse gas emissions through carbon sequestration. Microbial communities in the soil influence many ecosystem processes such as nutrient acquisition, C and N cycling, and soil formation (Heijden et al. 2008). Changes in precipitation patterns can effect microbes in these grasslands by causing shifts in community composition, and changes in nutrient cycling and decomposition. Many microbial activities can be directly correlated with water availability, and drought conditions may be detrimental to these grazed grassland ecosystems (Gray et al. 2011). Summer months and differences in time lead to changes in temperature and rainfall patterns, similarly having the potential to alter activity and structure of microbial communities.

Objective

- Determine the effects of drought conditions and time on microbial communities in grazed and annually burned grasslands.

Materials and Methods

- The study was conducted in native tallgrass prairie located at the Konza Prairie Biological Station, in the Flint Hills of eastern Kansas, USA.
- In June 2015, samples were taken from an annually burned plot (C1A) within the Konza Prairie. Samples were analyzed for gravimetric soil water content and phospholipid fatty acids (PLFA).
- In July 2015, samples were taken from plot C1A and divided into 3 treatment groups: time zero, moist, and dry. Time zero samples were analyzed immediately, while the moist and dry samples were left in the incubator for 6 days (moist samples covered in mason jars, dry samples spread on a tray and left to open air). All treatment groups were analyzed for gravimetric soil water content and PLFA.

Image 1: Soil Sample Collection

Image 2: Moist Treatment

Image 3: Dry Treatment

- Phospholipid Fatty Acids (PLFA) were extracted using a modification of the procedure by Bligh and Dyer (1959). A Thermo Scientific Trace GC-ISQ mass spectrometer was used to analyze the resulting fatty acids.
- PLFA data was analyzed to compare June vs July and moist vs dry treatments using analysis of variance (ANOVA)

Results

Study 1- Time (June VS. July)

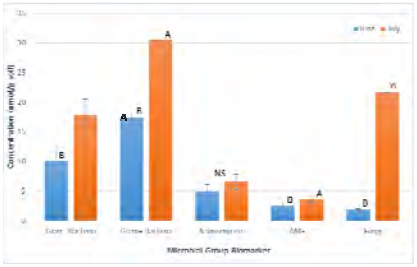

Figure 1: Microbial biomarker concentrations for June and July. Error bars represent standard error of concentration. Different letters (A and B) above bars indicate significant differences ($p<.05$). NS indicates no significant difference ($p>.05$).

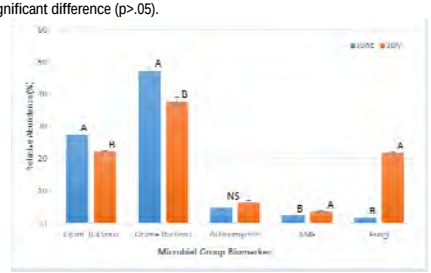

Figure 2: Microbial biomarkers relative abundance for June and July. Error bars represent standard error. Different letters (A and B) above bars indicate significant difference ($p<.05$). NS indicates no significant difference ($p>.05$).

Time	Average % Moisture
June	26.45
July	24.55

Table 1: Soil moisture for plot C1A in months June and July. No significant difference between soil moisture contents.

Study 2- Drought Conditions

Biomarker	Concentration	Relative Abundance
Gram- Bacteria	0.31	0.28
Gram+ Bacteria	0.62	0.51
Actinomycete	0.29	0.77
AMF	0.50	0.59
Fungi	0.74	0.18

Table 2: ANOVA P values for concentration and relative abundance of each microbial group biomarker. P>.05 meaning no significant difference.

Treatments	Average % Moisture
Time Zero	24.55
Moist	28.34
Dry	5.07

Table 3: Average % Moisture for each treatment group.

Discussion

Study 1- Time (June VS. July

- Soil moisture was not significantly different between June and July.
- Total PLFA concentration doubled in July.
- Significant increase in every biomarker except actinomycetes.
- Largest increase shown in fungal group.
- Gram positive and gram negative bacteria decreased in relative abundance.
- Ratio of fungi to bacteria increased.
- Ratio of gram positive bacteria to gram negative bacteria increased.
- No difference in average amounts of rain in the 28 days preceding collections, but the time before June had smaller, more frequent rainfall events while the time before July had heavy, less frequent rainfall events.

Study 2- Drought Conditions

- Dry treatment had significantly less soil moisture than time zero and moist treatments.
- No significant difference in microbial community between the three soil moisture treatments.

Conclusion

In Konza Prairie soil, seasonal changes through June and July alter microbial communities. Total PLFA concentrations significantly increase, with the largest increase occurring in fungi. This change causes a decrease in relative abundance of gram positive and gram negative bacteria, and also an increase in the ratio of fungi to bacteria. Drought conditions were observed to cause no significant change in microbial communities, suggesting the microbes in the soil have a high tolerance for lack of soil moisture.

References

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