How does prescribed fire influence soil microbial composition and activity after an experimentally induced drought? Evidence for microbial resistance in a semi-arid savanna soil.

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Importance

- Drought and fire are expected to increase in the near future.
- While there are many studies on drought and fire individually, few assess their interactive effects on ecosystems.
- Prescribed fire is effective at preserving and protecting savanna vegetation from woody biomass encroachment, but not much is known about its impact on soil biologic properties.

Objective

- Our objective was to assess the relaltion of drought and fire on soil microbial communities in a semi-arid savanna as part of the Drought Net group.

Hypotheses

- Drought+fire would reduce microbial diversity from the reduction of soil moisture and organic matter loss on ignition.
- Drought and drought+fire would have lower enzyme activity due to soil moisture loss via vaporization and desiccation.

Methods

- Plots loacted at Texas A&M AgriLife Research Station in Sonora, Texas.
- Plots were established in accordance to the Drought Net protocol.
- 32, 5x5 meter plots were set up into 4 treatments consisting of ambient control, drought, fire, and drought + fire plots.
- Ring fires were administered in March, 2018 and again in August, 2019.

- Soil samples were collected at 0-5 cm. pH and soil moisture content, and bulk density were also measured.

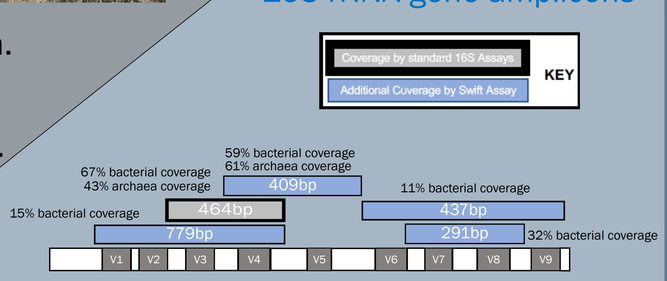
Enzyme	Function	SOM component
B-glucosidase	Cellulose decomposition, releases glucose	C cycling and decomposition
Cellobiohydrolase	Catalyzes hydrolysis of cellulose	
Xylosidase	Involved in hemi-cellulose decomposition	
Phosphatase	Phosphorus acquisition	P cycling
Chitinase (N-acetyl glucosaminidase)	Assists in decomposing chitin-based compounds, produces plant available N	N degradation

- Enzyme activity was determined by a fluorescence based enzyme assay.

Semi-arid savannas can withstand drought and fire disturbances.

- 16S genes were sequenced using the Swift Amplicon Method.

16S rRNA gene amplicons



- A single pool of 7 amplicons covered regions V1-V9 of the bacterial gene, which was used to determine taxa.

Results

Diversity does not differ among treatments.

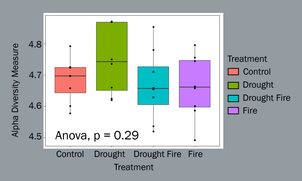


Figure 1. Box and whisker plot showing alpha diversity does not differ by treatment.

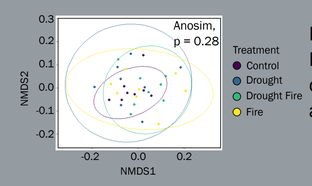


Figure 2. NMDS plot showing beta diversity does not differ among treatments.

Drought has more unique Actinobacteria and Proteobacteria than all other treatments.

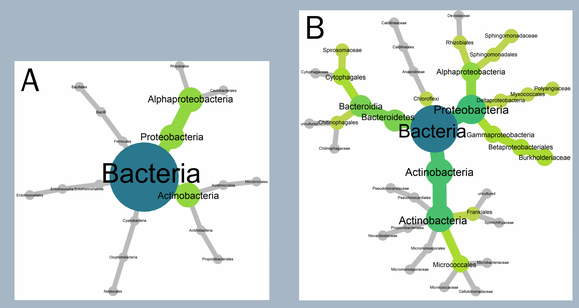


Figure 4. Phylogenetic trees showing unique bacterial taxa in (A) the fire treatment and (B) the drought treatment. Node sizes are determined by the abundance of each taxa.

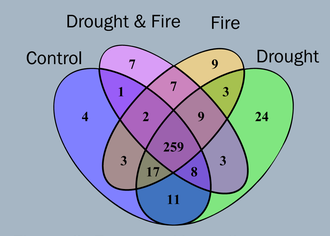


Figure 3. Four-way Venn diagram showing unique 16S taxa by tratment.

Treatment	Domain	Phylum	Class	Order	Family
Drought	Bacteria	Actinobacteria	Actinobacteria	Frankiales	Sporichthyaceae
					uncultured
				Micrococcales	Cellulomonadaceae
					Microbacteriaceae
					Micrococcaceae
				Micromonosporales	Micromonosporaceae
				Propionibacteriales	Nocardioidaceae
				Pseudonocardiales	Pseudonocardiaceae
		Bacteroidetes	Bacteroidia	Chitinophagales	Chitinophagaceae
					uncultured
				Cytophagales	Cytophagaceae
					Spirosomaceae
		Chloroflexi	Anaerolineae	Caldilineales	Caldilineaceae
			Gitt-GS-136		
		Proteobacteria	Alphaproteobacteria	Rhizobiales	Devosiaceae
					Rhizobiales Incertae Sedis
				Sphingomonadales	Sphingomonadaceae
			Deltaproteobacteria	Myxococcales	Polyangiaceae
			Gammaproteobacteria	Betaproteobacteriales	Burkholderiaceae
Fire	Bacteria	Actinobacteria	Acidimicrobiia	Microtrichales	Ilumatobacteraceae
			Actinobacteria	Propionibacteriales	Nocardioidaceae
		Cyanobacteria	Oxyphotobacteria	Nostocales	Nostocaceae
		Entotheonellaeota	Entotheonellia	Entotheonellales	Entotheonellaceae
		Firmicutes	Bacilli	Bacillales	Bacillaceae
		Proteobacteria	Alphaproteobacteria	Caulobacterales	Hyphomonadaceae
				Rhizobiales	Rhizobiales Incertae Sedis

Table 1. Taxonomic breakdown of Unique bacterial taxa for the drought treatment and the fire treatment.

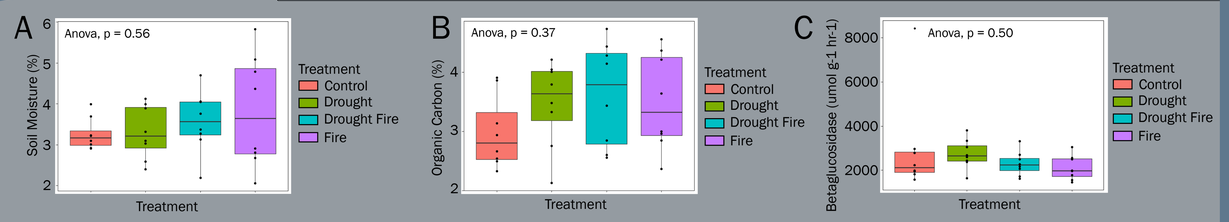


Figure 5. Box and whisker plots showing (A) soil moisture, (B) organic carbon, and (C) betaglucosidase activity. Each measurement shows no significance among treatments. Of the five enzmes measured, none showed any significant changes.

Conclusions

- Drought + fire did not reduce microbial diversity.
- Soil moisture did not decrease across treatments, which is resulted in no change in enzymatic activity across treatments.
- Savanna ecosystems show tolerance to presribed fires, which indicates that prescribed fires are a useful method to remove woody biomass without negatively impacting belowground biological processes.

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