Impacts of Fire and Post-Fire management on Nitrification and enzymatic activity of Beta-glucosidase and Peroxidase in Chaparral soils

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Introduction

- Fire is a natural disturbance that shapes Southern California chaparral ecosystems
- Climate change has increased fire intensity and frequency
- This research fills potential gaps in understanding the effects of hydroseeded and naturally recovering soils after fire disturbance on microbial activity and abundance
- Nitrification is known to increase in burned soils but effects on enzymatic activity is poorly known

Fig. 1. Photo of CSUSM campus near the "Cocos" wildfire in May 2014.

- β-glucosidase catalyzes the break down of cellulose into glucose
- Peroxidase catalyzes the break down of lignin.
- Nitrification is the conversion of NH_4^+ into NO_3^- by nitrifying bacteria

Methods

- Research sites consisted of unburned (U) and burned, naturally regenerating (N) and hydroseeded (H), sites at CSUSM **(Fig.2)**.

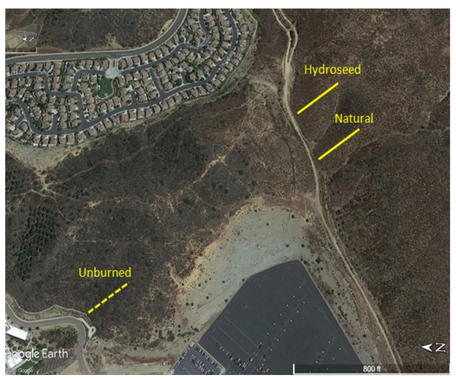
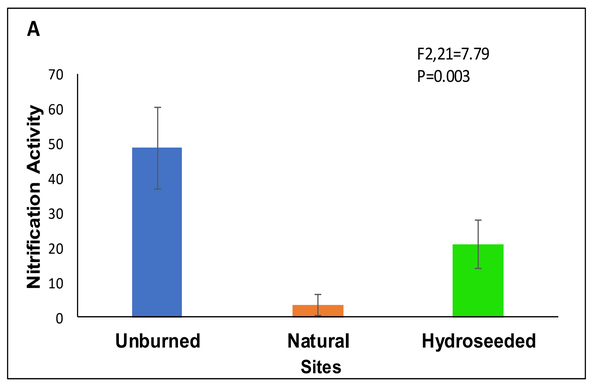
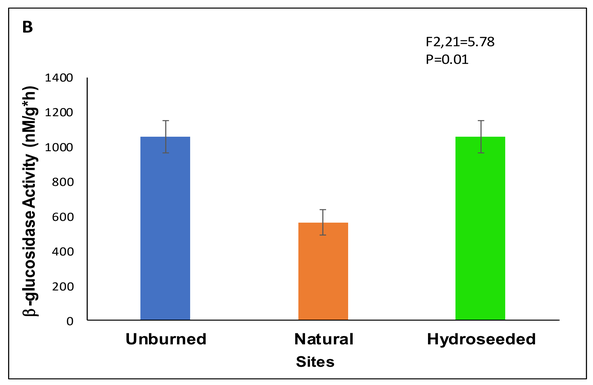


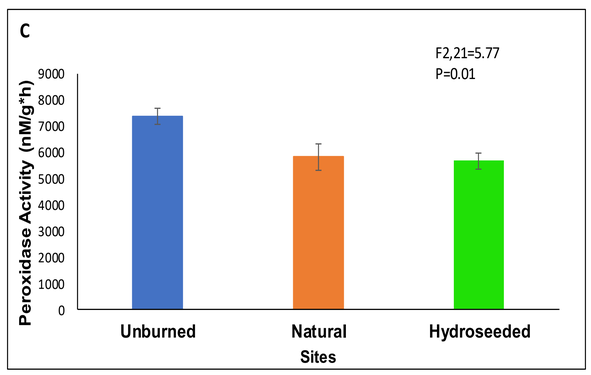
Fig. 2. Aerial photo of CSUSM presenting the location of the unburned (U), burned-naturally regenerating (N), and burned-hydroseeded (H) sites.

- Topsoil (0-10 cm) was collected in February 2019 from 24 randomly located plots (n = 8 plots/site)
- Soil was analyzed for nitrification (Vourlitis et al. 2017) and β-glucosidase and peroxidase activity (Jackson et al. 2013).
- Genomic DNA was extracted using ZymoBIOMICS™ DNA Microprep Kit
- 16s rRNA V3-V4 regions were targeted and analyzed using 16S Library Preparation Workflow
- Genomic data was analyzed through Galaxy pipeline
- Statistical differences between means were analyzed using one-way ANOVA.
- Relationships between nitrification, enzyme activity, and soil variables were assessed using linear correlation.

Results and Discussion







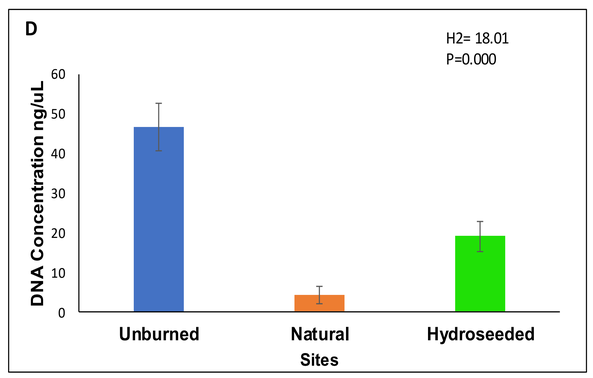


Fig 3. Mean (±se; n=8) Nitrification (A), Beta-glucosidase (B), Peroxidase activity (C) and DNA concentration (D) from the unburned (blue bars), burned-naturally generating (orange bars), and burned-hydroseeded (green bars) sites on the CSUSM campus. Also shown are results from One-way ANOVA (F statistic, effect and error degrees of freedom, and p value) for A,B,C and Kruskal-Wallis Test (H-value, degrees of freedom, and p value) for D. (▪ indicates LN+2 transformation).

- The unburned site had significantly higher nitrification than the natural and hydroseeded sites (**Fig 3A**).
- There was little difference in β-glucosidase activity between the burned and hydroseeded sites (**Fig 3B**).
- The unburned site had a significantly higher peroxidase activity than the hydroseeded site (**Fig 3C**).
- The unburned site had a significantly higher nitrifier abundance than the natural and hydroseeded site (**Fig 3D**).

Table 1. Correlation results of microbial activity and selected variables. (NS=not significant).

	DNA	Peroxidase	β-glucosidase	pH	Soil Moisture
Nitrification	r = 0.90 p < 0.001	r = 0.57 p = 0.003	r = 0.45 p = 0.029	NS	r = 0.71 p < 0.001
β-glucosidase	r = 0.58 p = 0.003	-	-	NS	NS
Peroxidase	r = 0.51 p = 0.012	-	-	r = -0.63 p = 0.001	NS

Table 2. Nitrifying bacteria results from the 3 different sites

	Nitrifying bacteria (%)
Natural	31
Unburned	31
Hydroseeded	21

- The burned-naturally regenerating and unburned sites contained the same percentage of nitrifying bacteria.

- Nitrification, β-glucosidase, and peroxidase activity were positively correlated with DNA abundance.
- Peroxidase activity was negatively correlated with soil pH.
- Nitrification rates positively correlated with soil moisture.

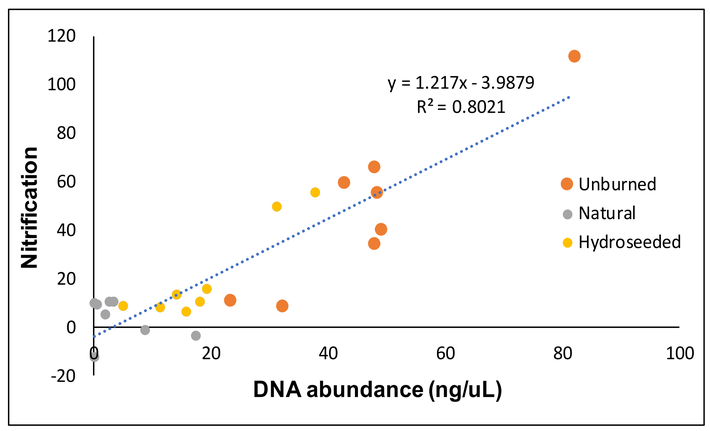


Fig. 4. The effect of DNA abundance on nitrification at the unburned, burned-naturally generating, and burned-hydroseeded sites on the CSUSM campus.

- The burned-naturally regenerating site contained a narrow low-range of nitrification.
- The burned-hydroseeded sites contained a wide medium-range of nitrification.
- The unburned site contained the widest highest- range of nitrification.

Conclusions

- Hydroseeding had a positive effect on nitrification, DNA concentration, peroxidase and β-Glucosidase activity compared to the naturally recovering site
- Fire has long term effects on microbial abundance and activity
- This study may provide important information for appropriate post-fire management methods

Literature cited

Vourlitis, GL *et al*. (2017) *Ecological Engineering* **102**: 46–54.

Jackson, CR *et al.* (2013) *Journal of Visualized Experiments* **1**:80

Acknowledgements

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