Fire, NOT Grazing

influences soil microbial diversity in a semi-arid savanna

SPEAKER: SIVU SITUNGU

UNIVERSITY OF THE
WITWATERSRAND

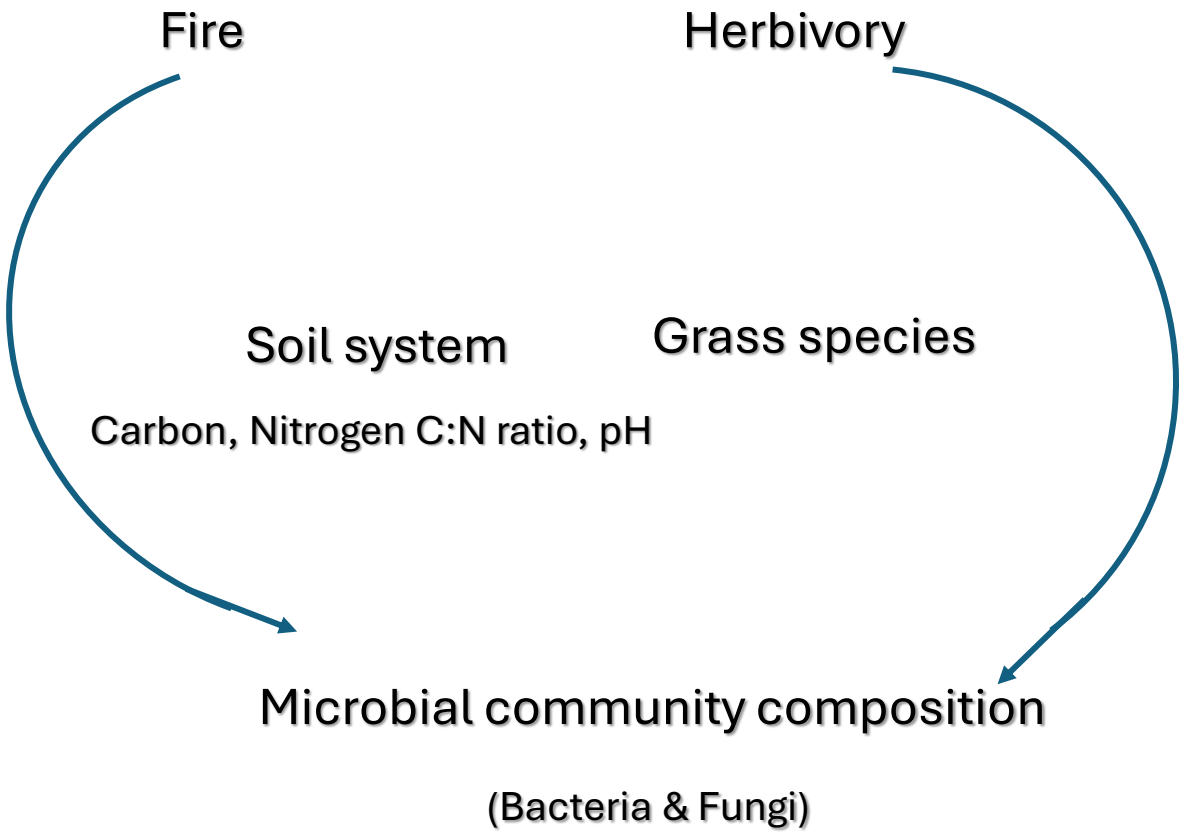
In African Savannas, fire and herbivory coexist

Prescribed fires are used as a management tool

Africa is the last continent with large mammal herbivores

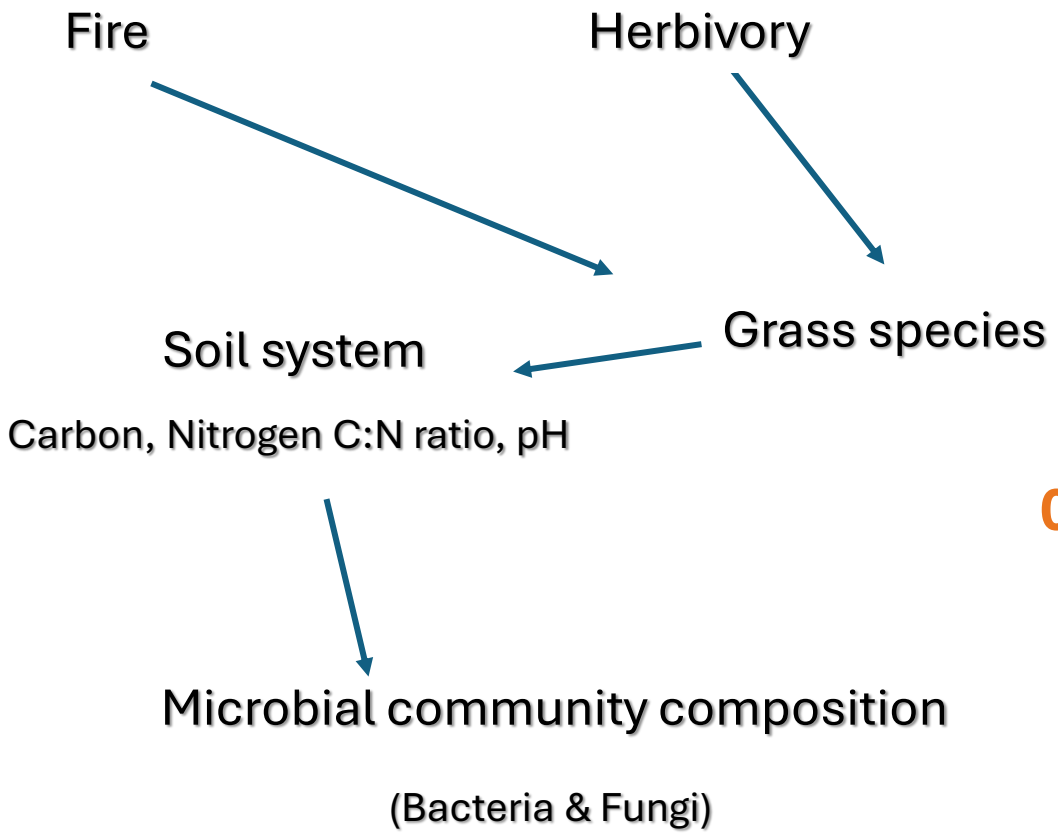
How do fire and herbivory affect below-ground microbial communities?

Research questions & hypothesis



01 Are fire, herbivory, or plant species the strongest drivers of microbial community structure?

Research questions & hypothesis



02 Is there any evidence that differences in microbial composition is mediated by soil properties

03 Which functional groups are most responsive to soil chemical properties?

Satara Fire Experiment

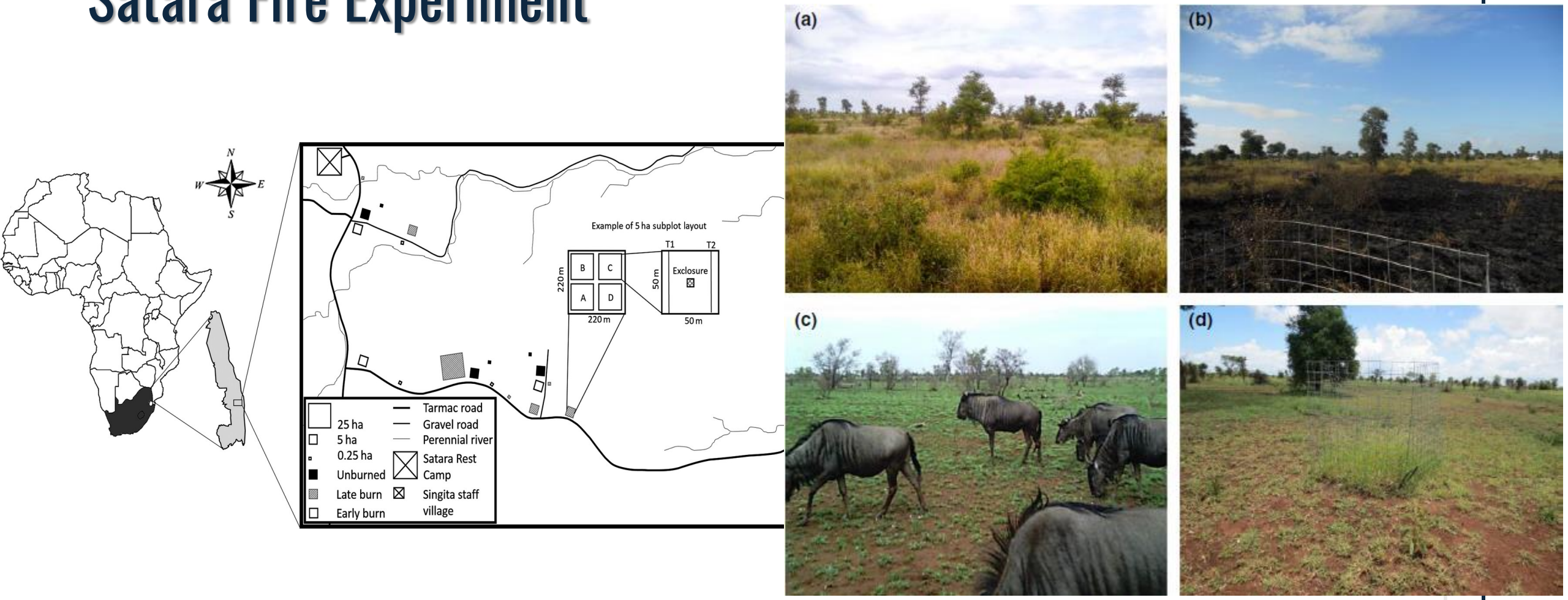


Figure 1: Landscape-level experimental burn plot in the Satara, Kruger National Park (Donaldson et al. 2017)

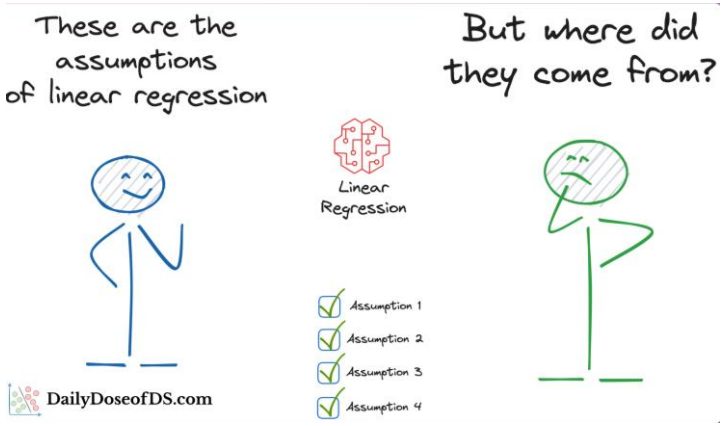
Data collection

Soils collected under each grass tussock

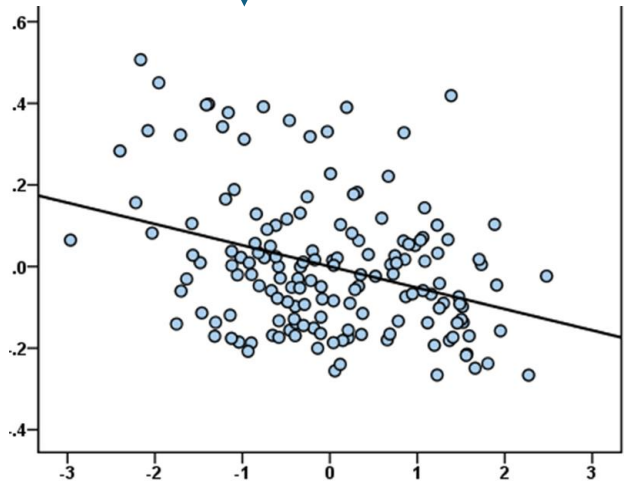
Used Deays® Power Soil® Kit (Qiagen) to extract the microbial DNA

Soil pH, % C, %N and C:N ratio were determined

Used Illumina Nextera tagged primers for Bacterial 16S rRNA & fungal ITS regions

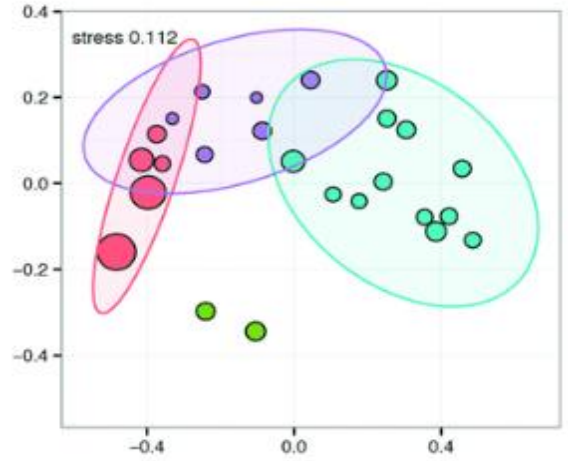


S = glmmTMB (S ~ Fire*Herbivory + (1 | Grass), family = poisson, data)



Plot of best model

R Studio



Bray-Curtis dissimilarity

#649 **Permanova (vegan::adonis2)**

Table 1. The effect of fire and herbivory on soil properties

Model	Effect	Coefficient	Confidence Intervals
Soil properties			
$pH_{(KCl)}$ ~ Herbivory + (1 | Grass)	Ungrazed > Grazed	0.08	0.001 - 0.15
C ~ Fire*Herbivory + (1 | Grass)	Control < Fire	-0.37	-2.46 -1.72
	Ungrazed > Grazed	3.90	1.56 - 6.24
	Fire*Control < Herbivory*Ungrazed	-2.77	-6.03 - 0.48
N ~Fire*Herbivory + (1 | Grass)	Control < Fire	-0.06	-0.23 - 0.11
	Ungrazed > grazed	0.33	0.13 - 0.52
	Fire*Control < Herbivory*Ungrazed	-0.27	-0.54 - 0.01
CN ~ Fire + (1 | Grass)	Control > Fire	0.77	0.24 - 1.29

Soil properties

A

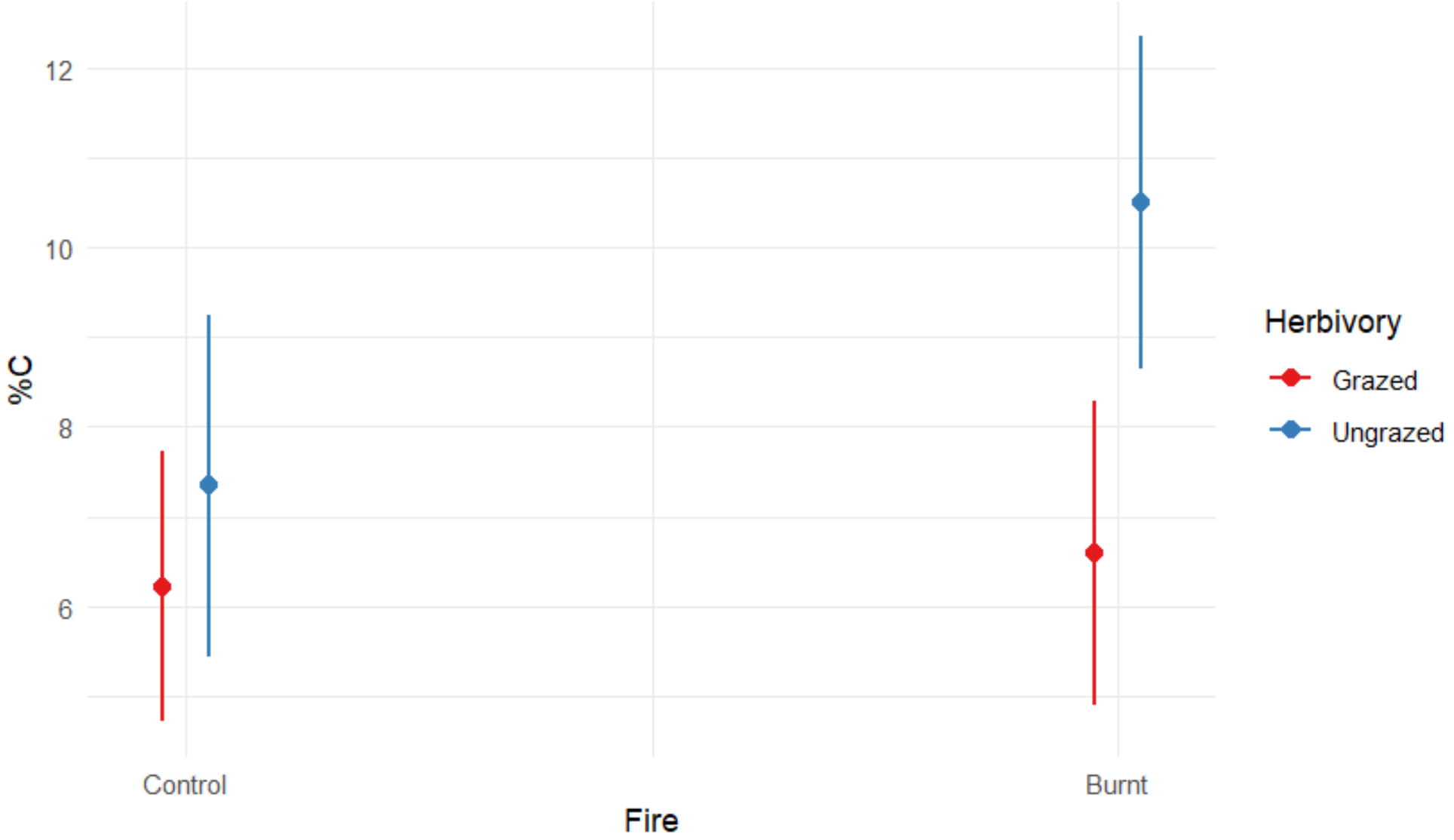


Figure 2. Visualisation of mixed effects of Influence of **(A)** grazing on soil pH and **(B)** % total Carbon

Soil properties

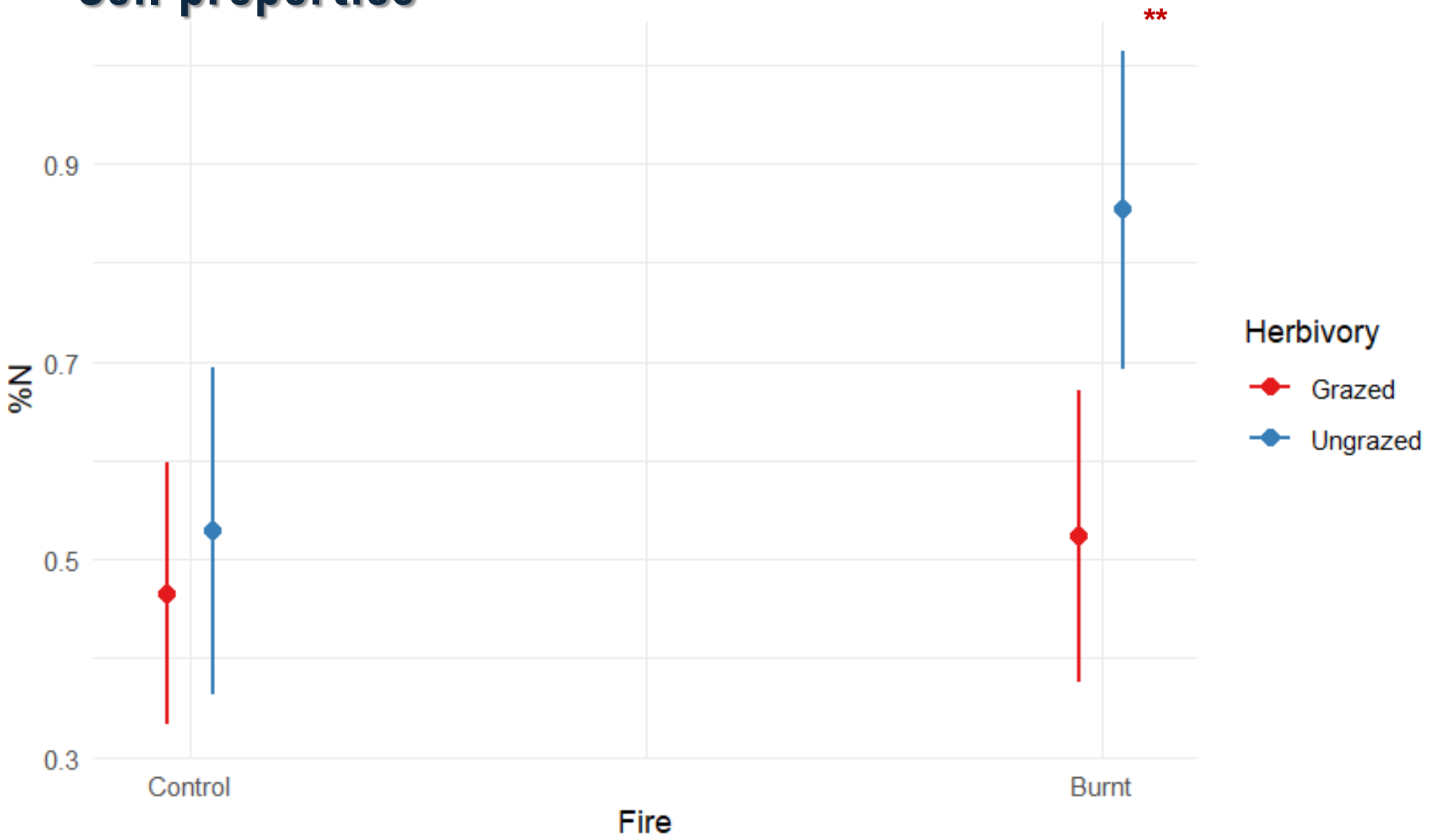


Figure 3. Visualisation of mixed effects of Influence of grazing on **(A)** % total Nitrogen and **(B)** C: N ratio

Table 1. The effect of fire and herbivory on alpha diversity

Model	Effect	Coefficient	Confidence Intervals
Bacterial Alpha Diversity			
H ~ Fire + (1 | Grass)	Control < Fire	-0.11	-0.11-0.04
S ~ Fire + (1 | Grass)	Control < Fire	-0.89	-0.25 -0.027
Fungal Alpha diversity			
H ~ Fire + (1 | Grass)	Control < Fire	-0.08	-0.15-0.01
S ~ Fire + (1 | Grass)	Control < Fire	-0.07	-0.33-0.18

α

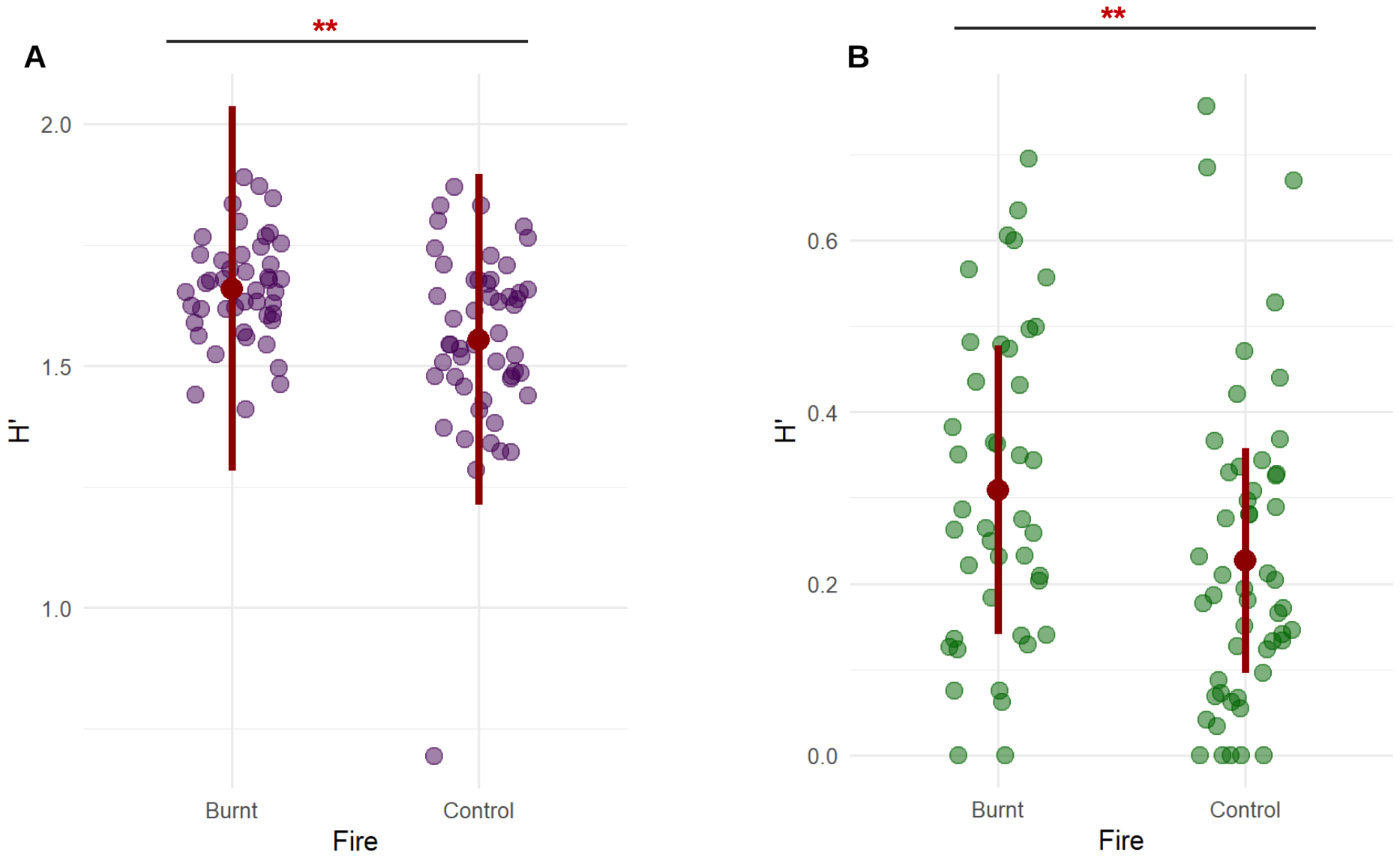


Figure 6. Shannon diversity (H') index for **(A)** Bacterial and **(B)** Fungal communities associated with the burned plots

α

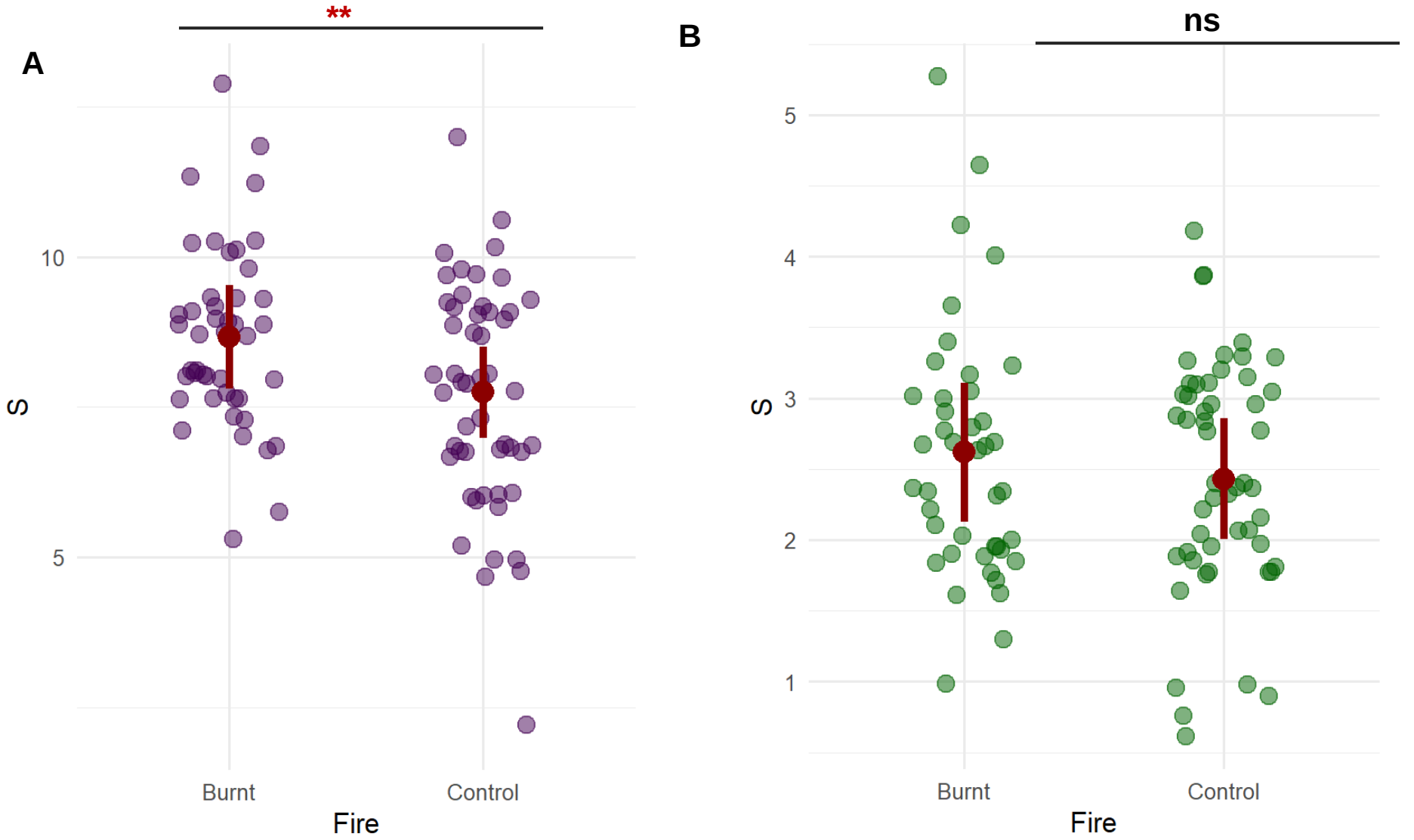


Figure 7. Microbial richness (S) index for **(A)** Bacterial and **(B)** Fungal communities associated with the burned plots

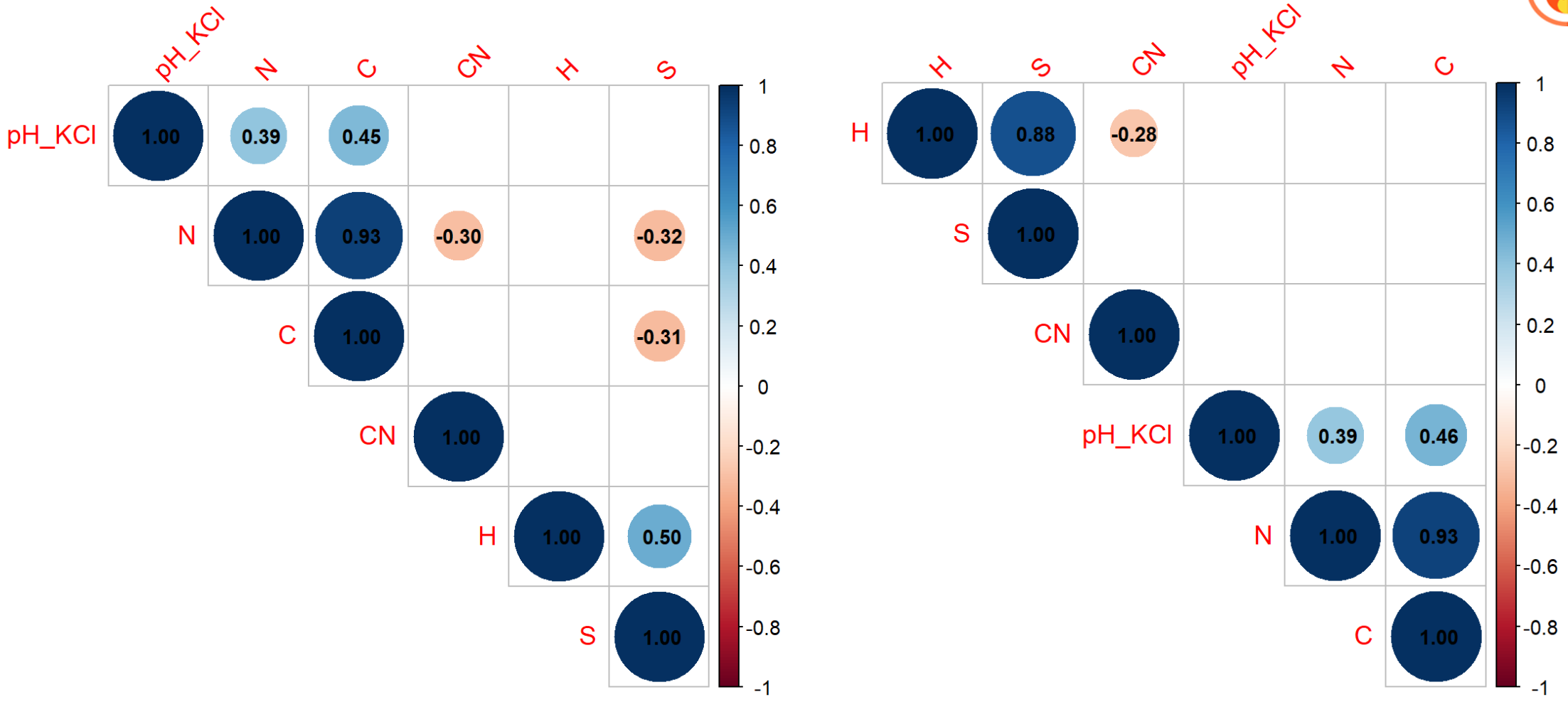


Figure 8. Spearman correlation between soil properties and bacterial alpha diversity index for the burned treatment in Satara

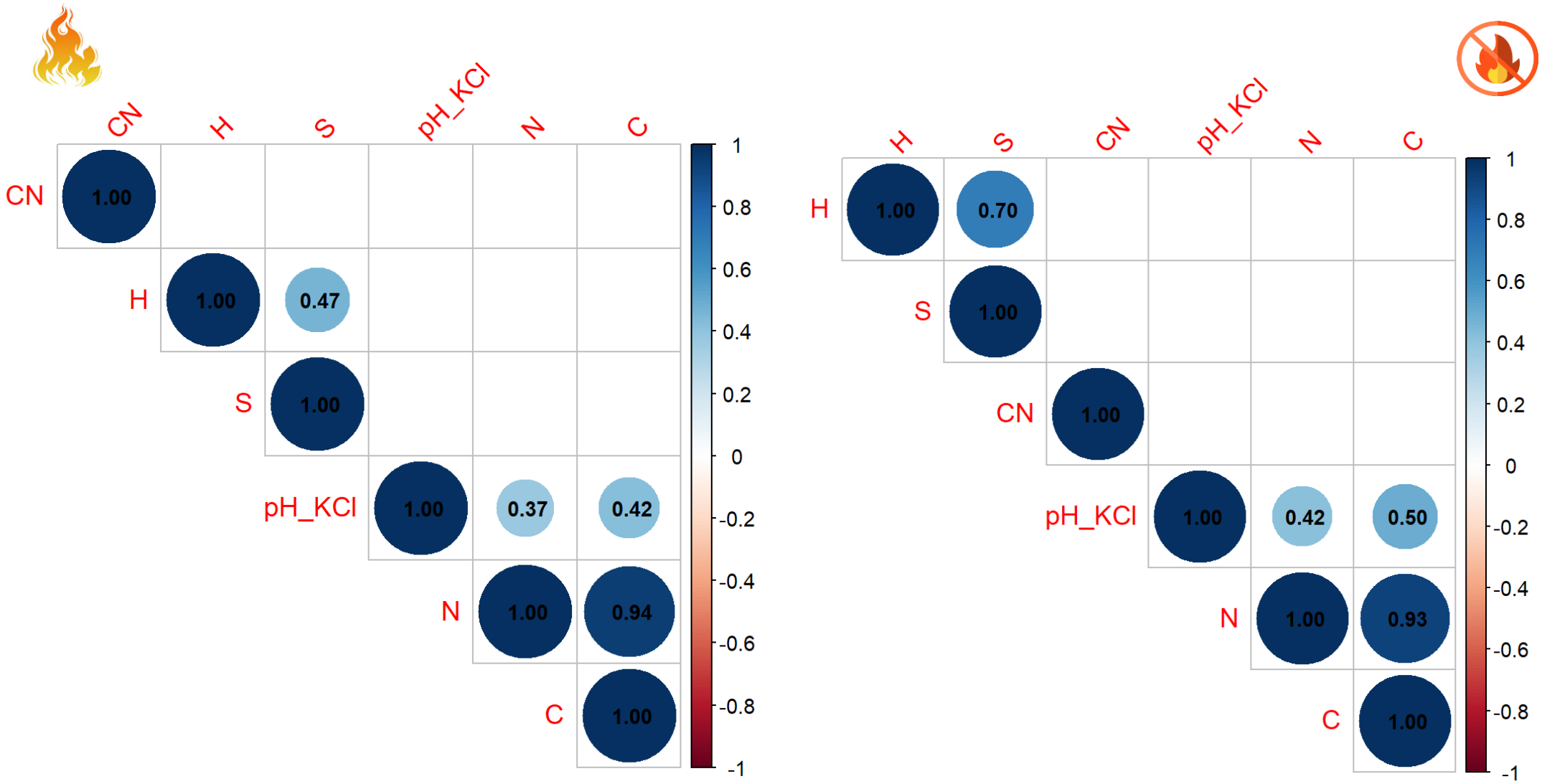


Figure 9. Spearman correlation between soil properties and fungal alpha diversity index for the burned treatment in Satara

β

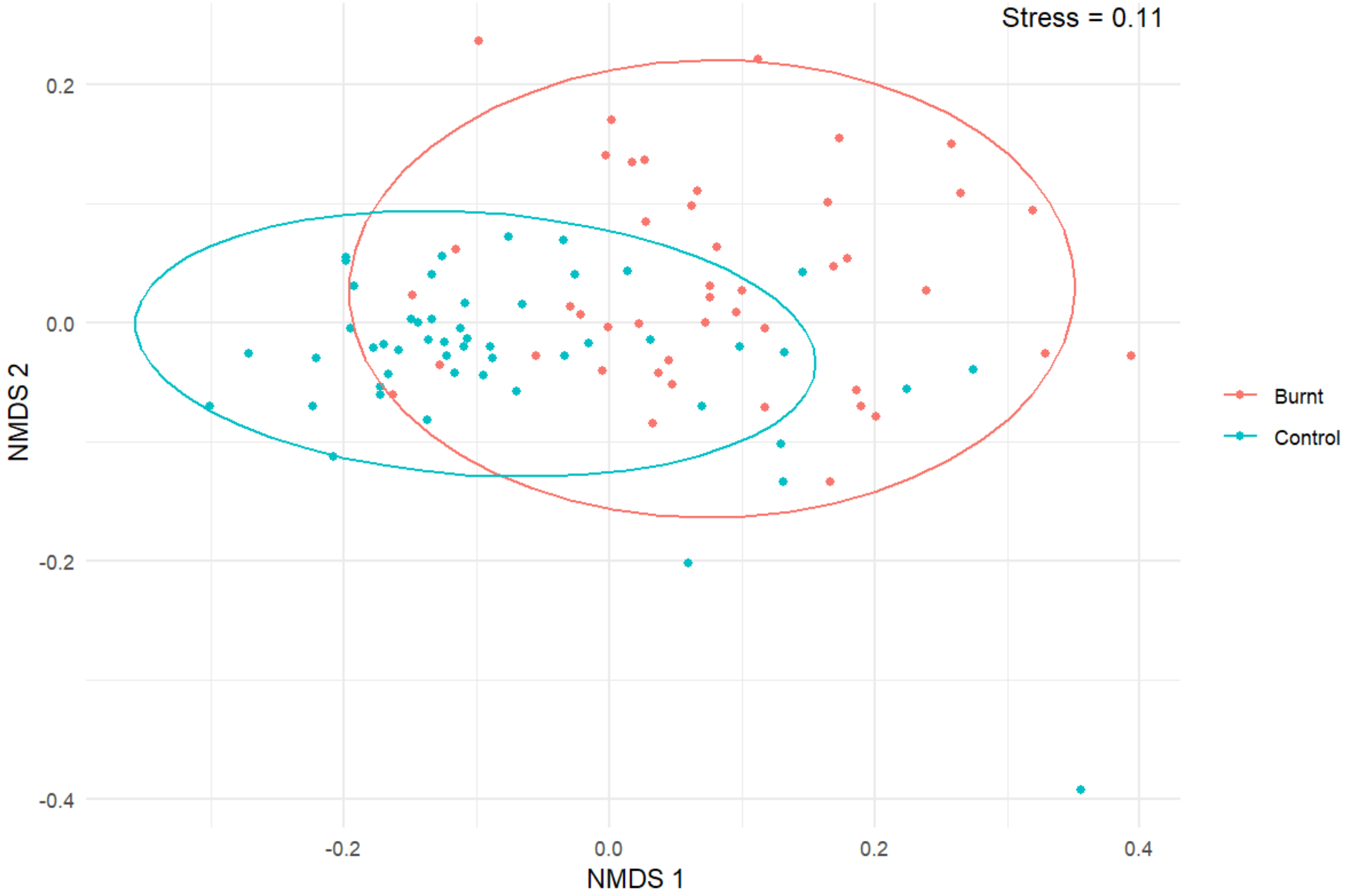


Figure 10. Non-Metric Multi-Dimensional Scaling (NMDS) plot of Bacterial communities associated with soils collected from the Satara fire experimental burned plots (PERMANOVA: p value = 0.001)

β

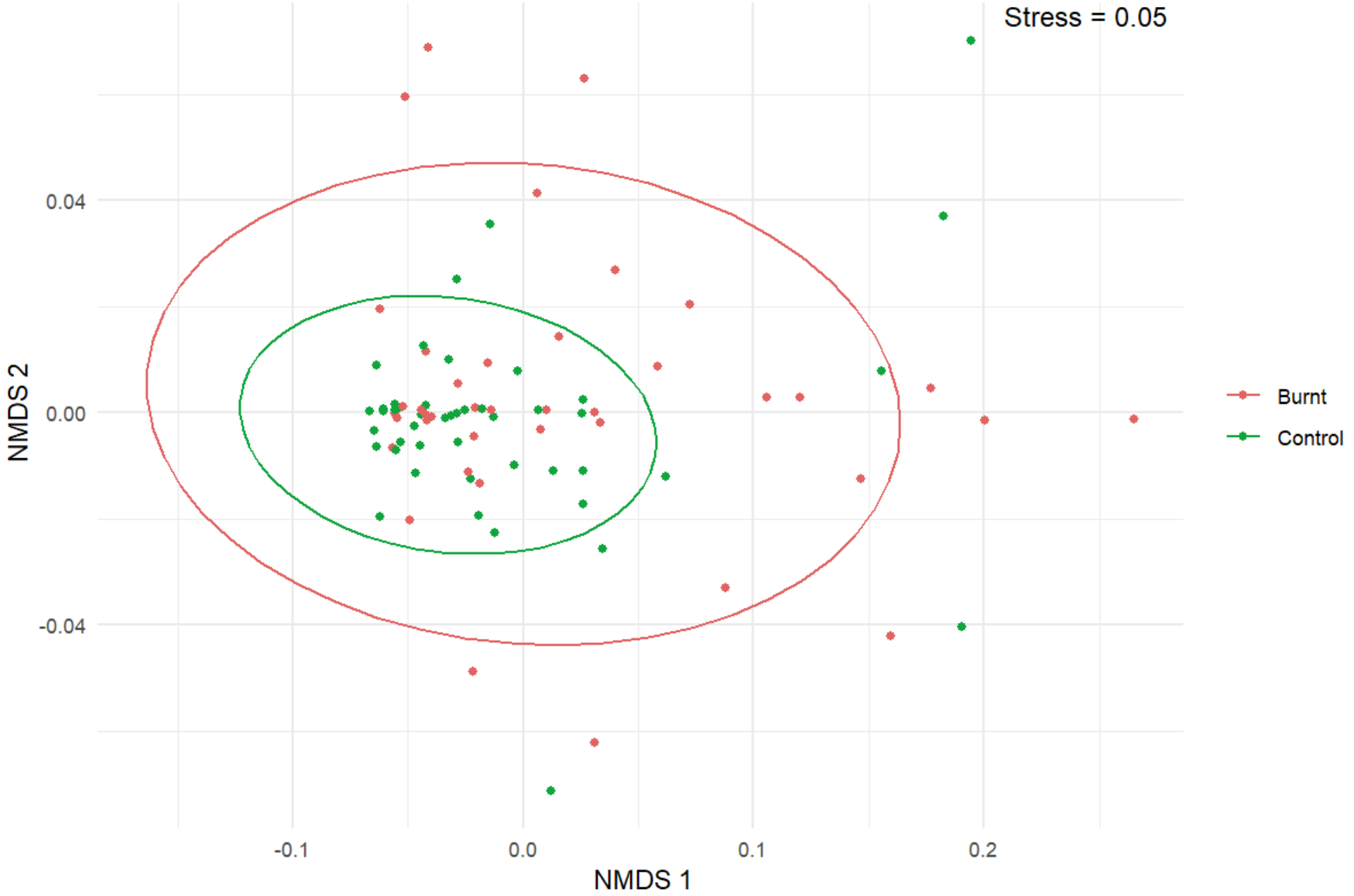


Figure 11. Non-Metric Multi-Dimensional Scaling (NMDS) plot of **(A)** Bacterial and **(B)** Fungal communities associated with soils collected from the Satara fire experimental burned plots (p value =0.07)

SUMMARY

1. The presence of **herbivores** decreases soil pH, total Carbon and Nitrogen
2. **Fire and not herbivory** affects microbial diversity and community composition
3. Soil properties do mediate changes in microbial composition