The Effects of Grass Legume Bi-culture Defoliation on Soil Microbial Communities and Physico-chemistry

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Introduction

-Bi-cultures provide forage for livestock.

-Legumes decrease the need for external N inputs[1] due to their associated N fixing bacteria

-Legumes can improve soil quality metrics like organic matter, nitrogen, water holding capacity, soil aggregation compared to monocultures

-Defoliation disturbance through grazing and or haying can alter growth aboveground and belowground and root exudation[6,] below-ground N fluxes[7]

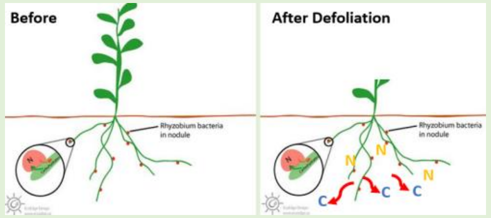


Figure 1. Defoliation increasing carbon and nitrogen flux belowground

Appropriately managing defoliation could enhance the benefits of grass legume bi-cultures

Overarching question: How does defoliation management intensity effect soil physico-chemistry and microbial communities?

Objective: Survey soil physico-chemistry and microbial communities under defoliation frequency and severity treatments applied to grass legume bi-cultures

Design/Methods

-6 orchard grass (ORC) legume bi-cultures, alfalfa, red and white clover, and birdsfoot trefoil in a ratio of 30% legume + 70% ORC , and mixtures at 30% to 70% and 70% to 30% ratios

-Crossed cutting schedule 5 cuts and 3 cuts per year and cutting height 5cm (severe) and 10cm (moderate)

-sampled after 3 years

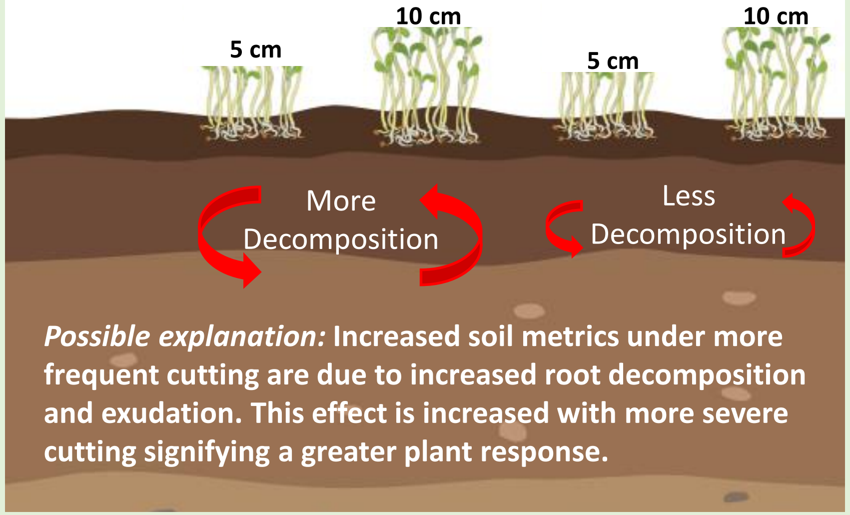
Figure 2. Grass legume bi-culture

Soil metrics were altered most by cutting frequency, but often depended on cutting severity. Bi-culture type explained no variation in soil metrics.

5 Cuts/Year: Water Holding Capacity (WHC) ↑, Gravimetric Water Content (GWC) ↑

3 Cuts/Year: Root Biomass ↑

	5 Cuts/Year, 5 cm	5 Cuts/Year, 10 cm	3 Cuts/Year, 5 cm	3 Cuts/Year, 10 cm
WHC	a	ab	b	ab
Root Biomass	b	b	a	a
Total Carbon	a	ab	b	ab
GWC	a	ab	b	ab
Microbial Biomass C	ab	ab	b	a



Possible explanation: **Increased soil metrics under more frequent cutting are due to increased root decomposition and exudation. This effect is increased with more severe cutting signifying a greater plant response.**

Figure 3. Green arrows indicate metric is greater under corresponding cut frequency. Shared letters between treatments signify no statistical difference.

Bacterial community composition was altered by cutting severity and frequency and correlated with soil physico-chemistry, but few differences in C and N cycling genes were observed.

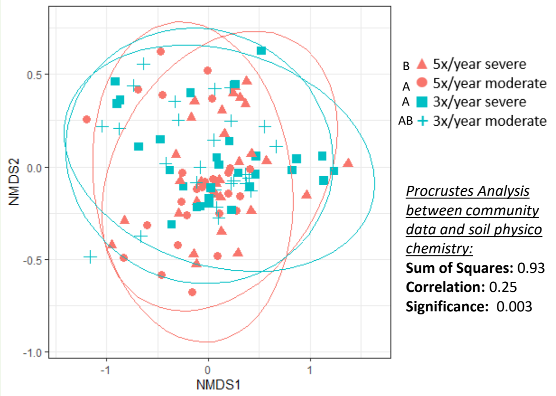


Figure 4. nMDS ordination of 16S amplicon sequence data, where each point represents a community from a sample. Shared letters (legend) signify no statistical difference. Measured soil metrics explain ~25% of the variation in microbial communities.

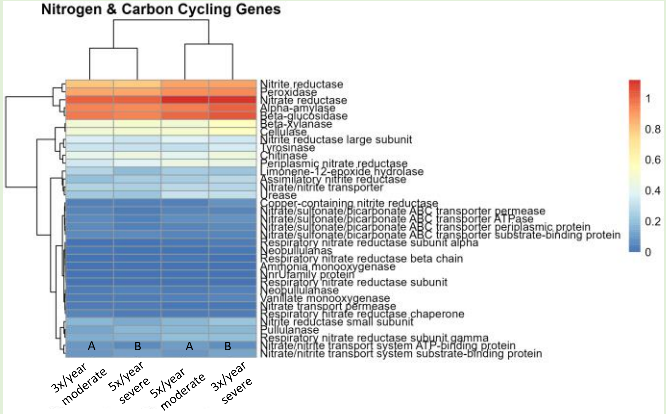


Figure 5. Relative abundance of key carbon and nitrogen cycling genes across treatments. Higher abundances are indicated by red and lower abundances by blue. Shared letters represent no statistical difference between treatments for a given gene.

Conclusions

Increased cutting frequency and to a lesser degree increased severity may improve soil quality metrics. While microbial community composition varied by treatment, the shifts were not substantial. Further, other than nitrate transport system ATP-binding protein, there were no changes in the relative abundance of key C and N cycling genes. Shifts in soil health metrics may have more to do with increased rates of biogeochemical transformations rather than changes in the pathways of transformations.

Acknowledgments/References

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