Poster #1805

Effects of biochar addition on soil microbial community and carbon use efficiency

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Introduction

Biochar addition to soil is proposed as a management strategy to improve soil fertility and sequester C. *We aimed to study long-term effects of biochar additions on soil microbial composition and activities.*

Material and methods: Oak-derived biochar was added at 0, 1, 5, 10, and 20% rate by weight to four soils (CO, IA, MIS, MN), and then incubated in lab for 30 months. Phospholipid fatty acids (PLFA) biomarkers were used to determine the effect of biochar addition on soil microbial biomass and community composition. Microbial Carbon Use Efficiency (CUE) was measured to investigates biochar effects on the balance between C losses and storage in soils.

Soil and biochar properties			
	C (%)	N (%)	pH
CO	0.68	0.07	8.717
IA	1.14	0.10	8.502
MIS	1.48	0.18	8.266
MN	1.97	0.19	6.663
Biochar	56.07	0.22	10.5

$$\text{CUE} = \frac{\text{C used for microbial growth}}{\text{Assimilated C}} \times 100\%$$

Results:

1. 1% or 5% biochar addition rates caused 20-100% increase in soil microbial biomass and 30-40% increase in CUE (Figure 1 and 2);
2. After 30 months incubation, soil microbial community composition was significantly altered by the biochar treatments (Figure 3). Biochar commonly increased bacterial biomass, especially for Gram(-) bacteria.

Biochar additions increased microbial biomass

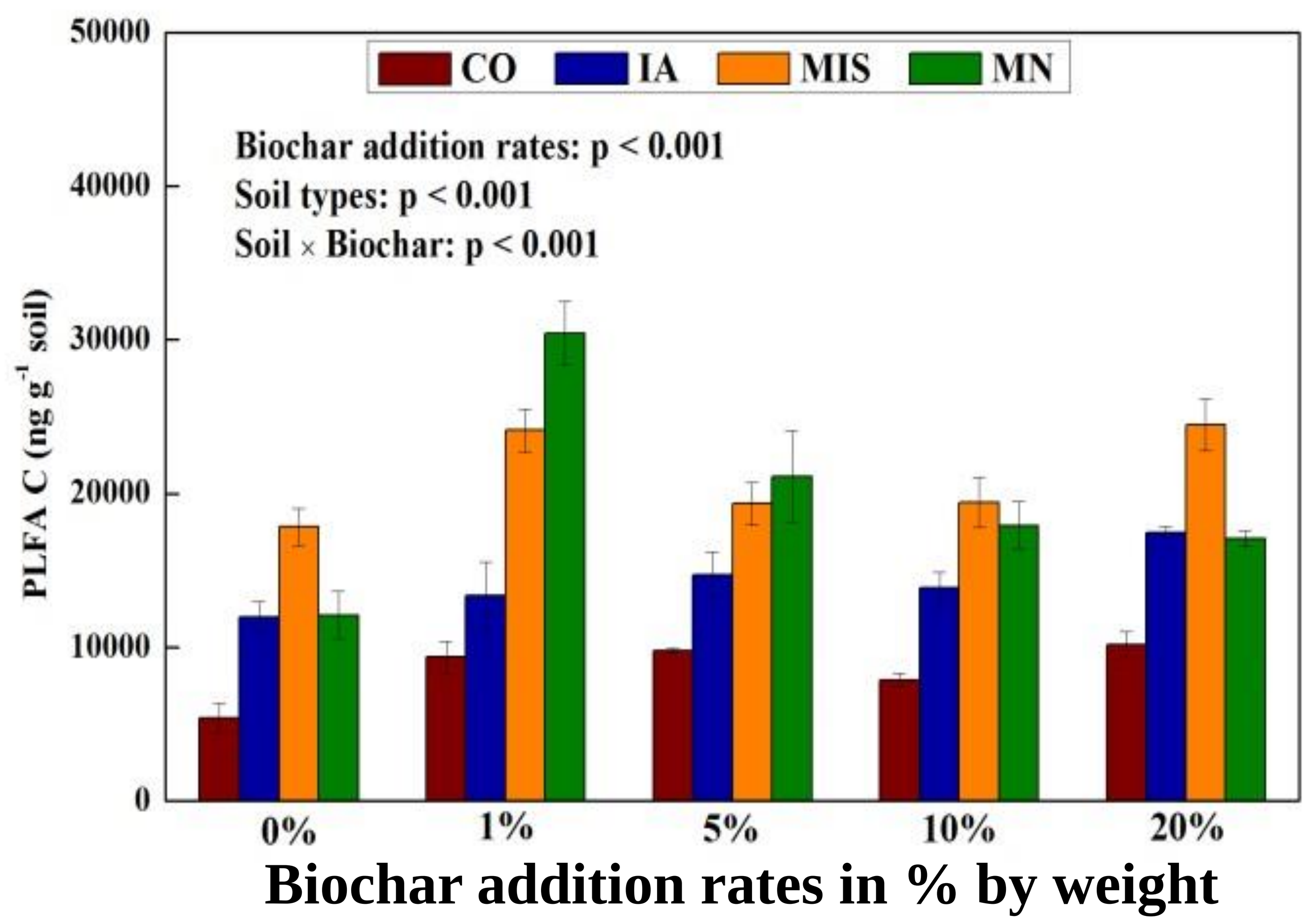

Figure 1: Biochar addition significantly increased microbial biomass after 30 months incubation, especially at the 1% addition rate. Higher biochar addition rates did not cause further biomass increases.

Biochar addition increased microbial CUE

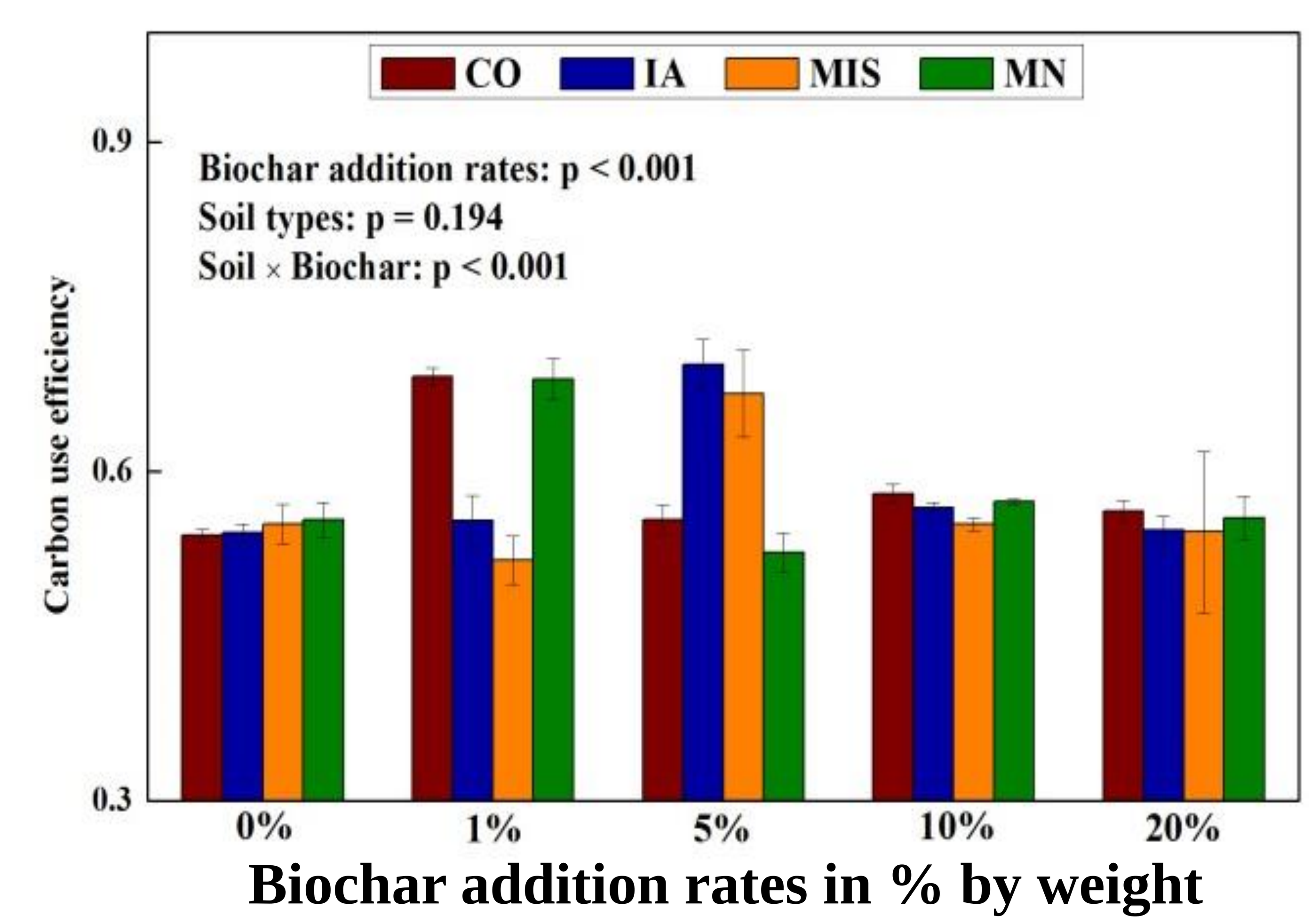

Figure 2: Microbial CUE was significantly affected by biochar addition rates, rather than soil types after 30 months incubation. CUE results were consistent to PLFA data, with the highest values at the 1% or 5% addition rate.

Biochar addition changed microbial community composition more and more over time

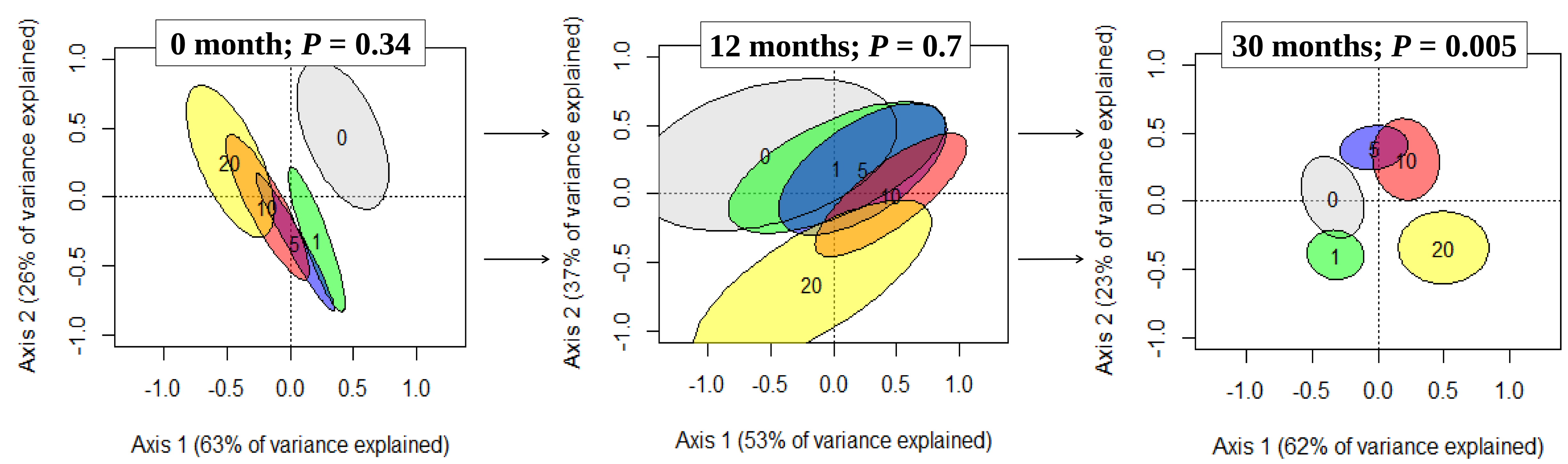

Figure 3: After 30 months incubation, PCoA analysis showed that biochar significantly changed soil microbial composition. (Data for the 0 and 12 months were from Gomez et al. 2013)

Differences of microbial groups along Axis 1 after 30 months incubation

Biomarker	scores	Group
c16:1n9	2.443	Gram(-) bacteria
10ME16:0	3.191	Actinobacteria
c18:1n11	4.268	Gram(-) bacteria
17:0cy	-1.253	Gram(-) bacteria
i-15:0	-2.264	Gram(+) bacteria
10ME17:0	-2.497	Actinobacteria

Correlation between soil properties and soil microbial groups relative abundance

(** P < 0.01)	pH	C:N
Gram(+) bacteria	**-0.545****	**-0.524****
Gram(-) bacteria	0.216	**0.623****
Actinobacteria	**0.553****	0.102

Conclusion

1) Biochar addition increased soil microbial biomass and activities, however, biomass and activities did not show linear relationships with biochar addition rates. Common field application rates (comparable to our 1-5%) are expected to be the most beneficial for soil microbial community.
2) Increases in soil pH and C:N appeared to drive the effects of biochar addition on soil microbial community, which strengthened over time.

References

Stewart et al. 2013. Global Change Biology Bioenergy, 5: 153-164

Gomez et al. 2013. European Journal of Soil Science, doi: 10.1111/ejss.12097

Acknowledgement

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