

Does stimulating decomposers with sodium and/or carbon affect agricultural phosphorus cycling?

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Introduction

- In Northwest Ohio, fertilizer phosphorus (P) runoff causes harmful algal blooms in Lake Erie
- Much of the P added to farms binds to soil particles and is relatively inaccessible to plants
- Decomposers play an important role controlling the availability of P in soils.
- C-substrate addition should increase decomposer abundance
- The Sodium Respiration Hypothesis (Kaspari et al. 2008) predicts that Na will increase the activities of soil heterotrophs in in-land systems.



Figure 1: Algal bloom in Lake Erie. Image by Allen and Simmon 2011, NASA Earth.

Objectives

1. Test how stimulating decomposer organisms affects P-cycling in agricultural fields in NW Ohio (Bender & van der Heijden. 2015).
2. Test if Na limitation, as predicted by the Sodium Respiration Hypothesis, applies to agricultural fields in NW Ohio.



Figure 2: a) Installation of a pitfall trap in a corn field in NW Ohio. b) Water running off of an agricultural field. Photo by Lynn Betts, USDA.

Methods

- Added 0.72 M NaCl solution and corn stover (C-rich substrate) to corn fields in NW Ohio
- After 3-4 days tested microbial respiration, extractable C, microbial biomass C and P, and K₂SO₄-extractable P

Results and Discussion

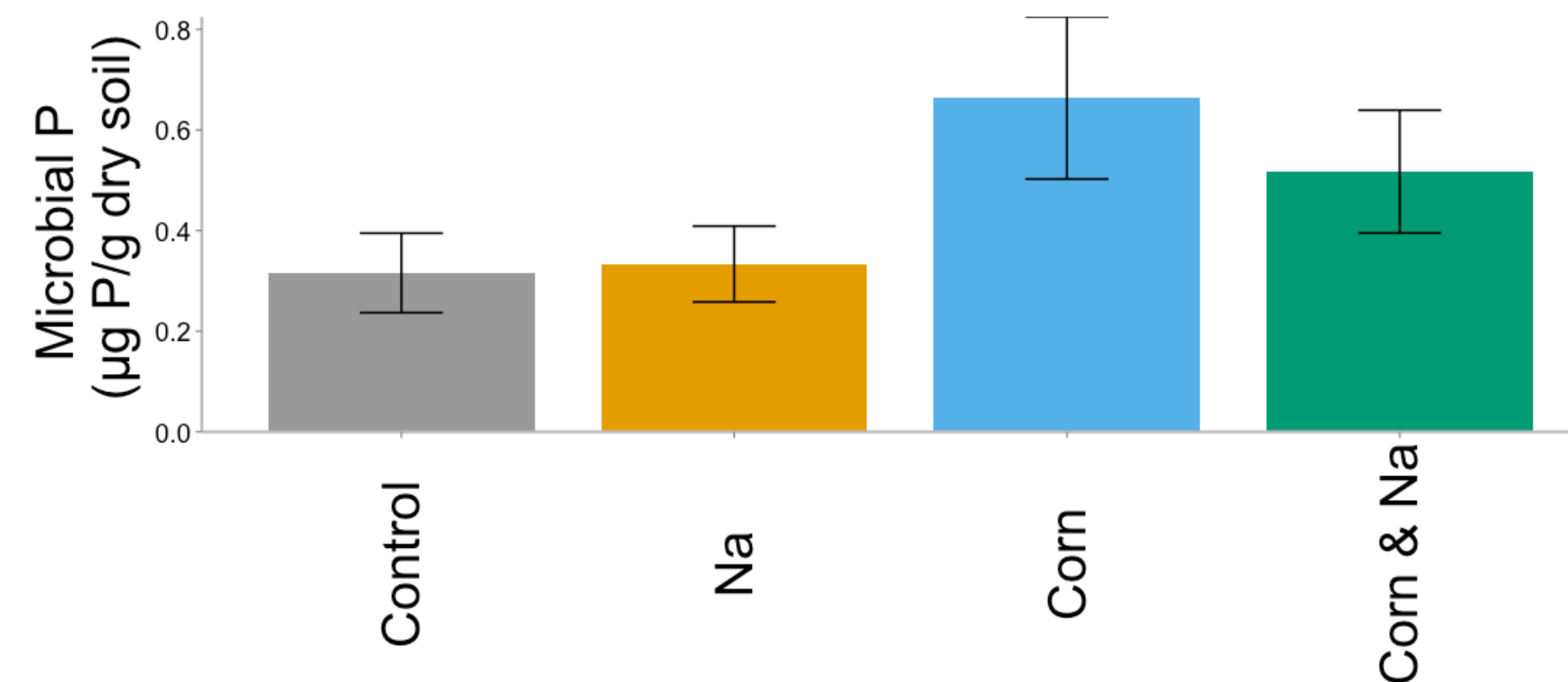


Figure 3: Microbial biomass P by treatment 3-4 days after treatment application. None of the treatments were significantly different from the control ($p > 0.05$, ANOVA)

Corn stover additions non-significantly increase microbial biomass P. Na additions do not affect microbial biomass P.

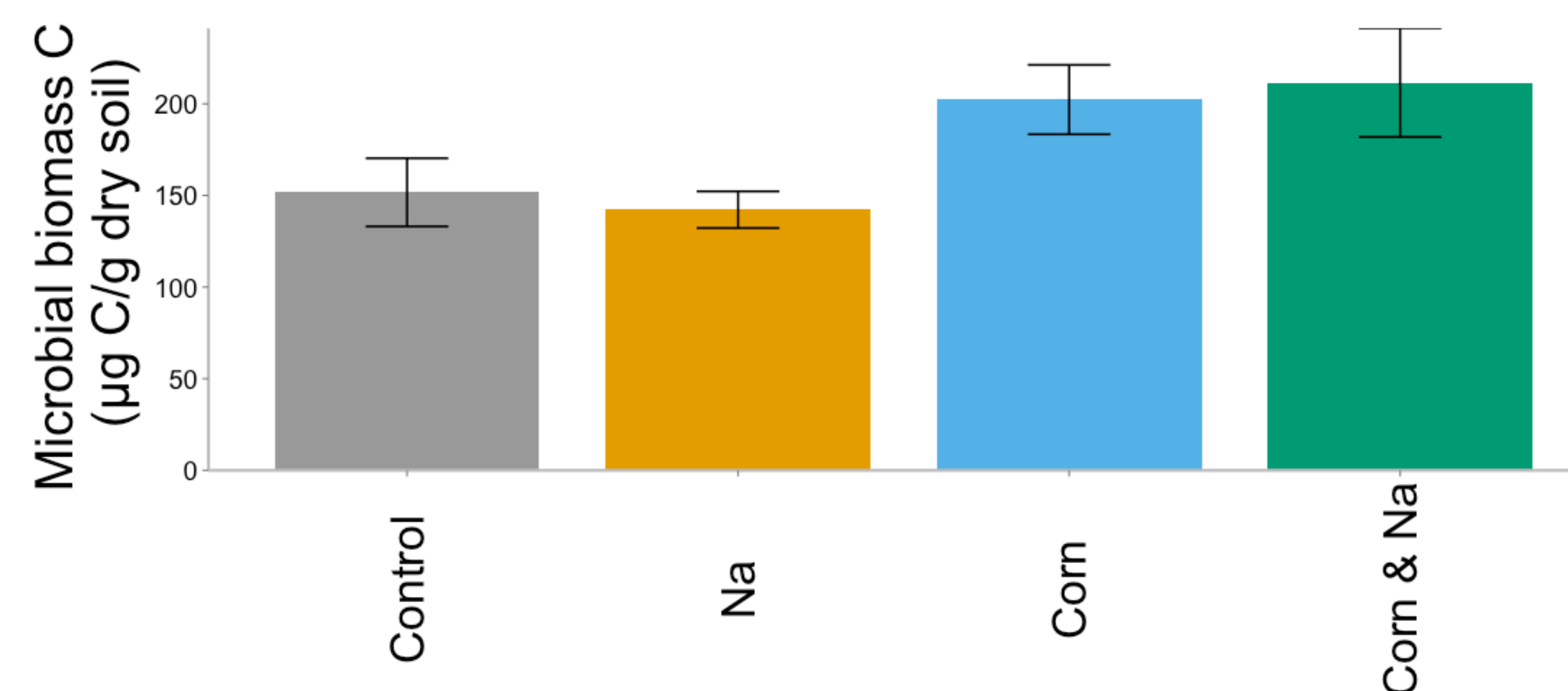


Figure 4: Mean microbial biomass C in each treatment 3-4 days after treatment application. None of the treatments are significantly different from the control ($p > 0.05$, ANOVA)

Corn stover amendments non-significantly increase microbial biomass C but Na amendments do affect microbial biomass C.

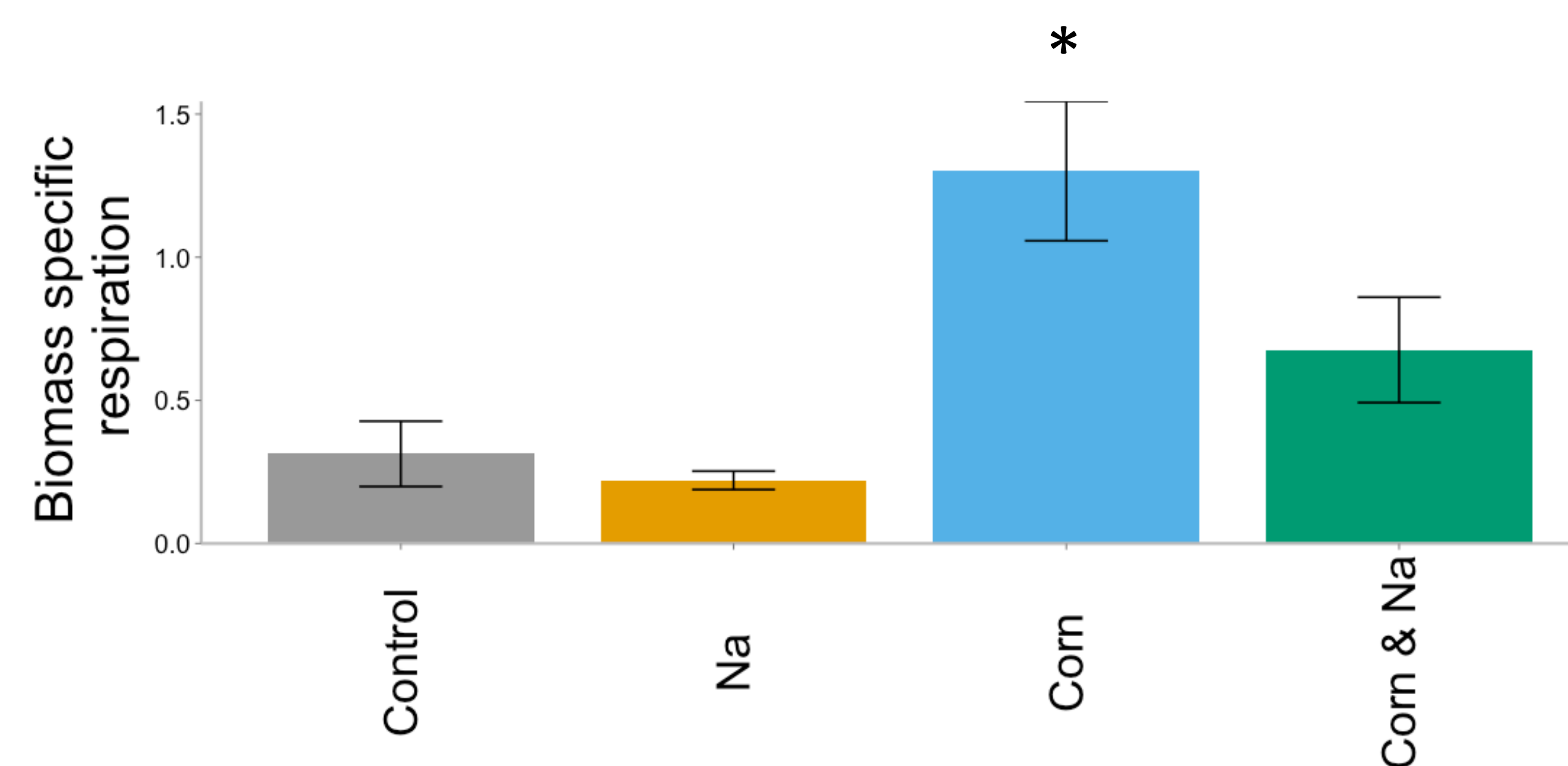


Figure 5: Microbial respiration per µg biomass C 3-4 days after treatment application. Only the corn treatment is significantly different from the control ($p < 0.05$, Tukey HSD).

Some of increase of microbial respiration with corn stover addition (blue bar) is lost when corn stover is combined with Na (green bar). Na alone does not impact microbial respiration.

Conclusions

- Over the short-term (3-4 days), Na does not affect microbial biomass C or P, though the additions of a c-rich substrate does non-significantly.
- In the presence of a c-rich substrate, Na depresses microbial respiration rate. This could be due to abiotic repression (e.g. Na toxicity) or to predation of microbes by soil fauna attracted to Na.
- Microbial P is increased by the addition of C-rich substrate, but K₂SO₄-extractable phosphate is not affected (data not shown).

Future Research

- Look at longer-term effects of Na and corn stover addition
- Directly measure macro-invertebrate biomass and diversity
- Test how sodium impacts macro-invertebrates
- Compare macro-invertebrate data to microbial and soil data



Figure 6: a) Soil collection. Photo by Pelini 2015. b) Colorimetric assay to determine soil nutrient concentration.

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For More Information

Barrow, N. J., and A. Debnath. 2014. Effect of phosphate status on the sorption and desorption properties of some soils of northern India. *Plant and Soil* 378:383–395.

Bender, S. F., and M. G. van der Heijden. 2015. Soil biota enhance agricultural sustainability by improving crop yield, nutrient uptake and reducing nitrogen leaching losses. *Journal of Applied Ecology* 52:228–239.

Kallenbach, C., and A. S. Grandy. 2011. Controls over soil microbial biomass responses to carbon amendments in agricultural systems: A meta-analysis. *Agriculture, Ecosystems & Environment* 144:241–252.

Kaspari, M., S. P. Yanoviak, and R. Dudley. 2008. On the biogeography of salt limitation: a study of ant communities. *Proceedings of the National Academy of Sciences of the United States of America* 105:17848–17851.

Strickland, T., L. Fisher, C. Korleski. 2010. Ohio Lake Erie Phosphorus Task Force Final Report. Ohio Environmental Protection Agency, Columbus, OH.

