Effects of Switchgrass (*Panicum virgatum* L.) on Deep Carbon Pools in Marginal Lands

Jialiang Kuang[1]* (kjialiang@ou.edu), Colin T. Bates[1], Amrita Bhattacharyya[2,3], Erin Nuccio[2], Arthur Escalas[4], Lauren Hale[5], Yuan Wang[6], Don Herman[3], Karis McFarlane[2], **Liyou Wu**[1], **Peter S. Nico**[3], **Malay Saha**[6], **Kelly Craven**[6], **Jennifer Pett-Ridge**[2], **Jizhong Zhou**[1], and **Mary Firestone**[7]

[1]The University of Oklahoma, Norman; [2]Lawrence Livermore, National Laboratory, Livermore, CA; [3]Lawrence Berkeley National Laboratory, Berkeley, CA; [4]University of Montpellier, Montpellier, France; [5]USDA-ARS, Parlier, CA; [6]Noble Research Institute, Ardmore, OK; [7]University of California, Berkeley, CA;

Project Goals: Switchgrass (SG; *Panicum virgatum* L.) is a perennial C4 grass native to the tallgrass prairies and a promising feedstock in the U.S. for bioenergy production. Capable of abundant biomass yield with minimal fertilizer or water, SG can survive on marginal soils, and even thrive once established. We hypothesize that successful establishment and sustainable cultivation of SG in marginal soils is in part enabled by beneficial plant-microbial interactions. We are investigating the succession of rhizosphere microbial communities, and ecosystem-scale effects of high- and low-performing SG plants grown in nutrient-limited soils in southern Oklahoma. The outcome of this research will provide a better genomic basis for SG cultivation in marginal soils, expand our knowledge of the interactions between soil microbiomes, plants and ecosystems, and ultimately guide efforts for translation into agronomic row crops.

This project aims to improve our understanding of the effects of long-term establishment of SG on soil carbon storage and nutrient availability. Specifically, we focus on how the accumulation of root biomass (i.e., the continuous input of slow C via root litter) in deep soil layers influences heterotrophic respiration by mediating the structure and functionality of microbial communities, which will consequently regulate the soil carbon balance. To this end, we attempt to address the differential responses (i.e., the dynamics of their decomposition/respiration along a depth profile) to plant residual carbon inputs (slow C) between long-term selected microbial communities from deep and shallow root systems.

To understand the impact of long-term cultivation of SG on carbon storage in marginal soils, we collected deep core soils (0-150cm) from two N/P poor sites (RR and PDF sites) with long-term (10yr) cultivation of perennial SG (deep-rooted system) and neighboring plots cultivated with annual row crops for more than 30 years (shallow-rooted system). We measured both soil C content and residence time (^{14}C) in these systems. Our initial results indicate that soils under 10 year SG cultivation have higher %C at all depths than soils that have been cultivated with annuals. Radiocarbon suggest that the marginal soils cultivated with SG have substantially younger C at all depths, indicating measurably higher soil carbon input with more modern ^{14}C. Ongoing measurements of soil chemistry and density fractionation will further illustrate the potential positive benefits of SG establishment on soil carbon and nutrient stocks.

To further explore how the accumulation of root biomass in deep soil layers influences the respiration of soil heterotrophic microorganisms and consequently regulates the soil carbon balance, we conducted a priming experiment using these deep core soils. We found a 60-day incubation with ^{13}C-labeled plant (oat) material significantly increased the microbial biomass (estimated by PLFA) in deeper soil layers. Adding

^{13}C plant material also significantly increased the carbon substrate (labile-C) utilization (measured by BioLog). Significant shifts in community structure were observed along a depth profile (16S rRNA gene high-throughput sequencing) yielding an increase of relative abundance of fast-growing bacteria and potential lignin degraders, especially in the shallow-rooted system, suggesting differential community level C degradation dynamics between the two root systems. Further measurements of soil microbial respiration (total CO_2 and ^{13}C-CO_2) are underway to elucidate differential response to external C input (slow C from root biomass) and priming effects between the two root systems. Our research will provide new insights into the prediction of deep soil carbon accrual after SG cultivation by comprehensively considering the dynamics of soil physiochemical properties and different carbon pools that are potentially mediated by microbial communities.

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