

## **Deeply rooted: impacts of depth and soil type on root biomass, carbon turnover and microbial communities under switchgrass cultivation**

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**Project Goals: Switchgrass (SG; *Panicum virgatum* L.) is a perennial C<sub>4</sub> grass native to the tallgrass prairies and a promising feedstock for bioenergy production in the U.S.A. Producing abundant biomass yield with minimal fertilizer or water, SG can survive on marginal soils, and thrives once established. Thus, SG is a model for low-input agriculture. Due to its deep rooting system, it may also serve as a means to augment soil carbon stocks. We are investigating the impact of switchgrass cultivation on different in nutrient-limited soil types in southern Oklahoma. Our goal is to determine how low-input switchgrass production in marginal soils may enhance ecosystem sustainability metrics such as C storage, nutrient availability, and soil food webs. 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, soil nutrient capital, plants and ecosystems, and ultimately guide efforts for translation into agronomic row crops.**

Two-thirds of terrestrial C is stored as soil organic matter (SOM), yet soil C stocks (particularly in agricultural systems) are not at capacity, and could accommodate an increased sink of up to 50t ha<sup>-1</sup>. But the fundamental mechanisms that regulate this vast pool (1500-1600 PgC in the top 1 m) remain elusive. What is clear, is that stabilized soil C is root carbon. Roots provide 30-40% of total soil organic C inputs, form a nexus for microbial transformations, and the primary source of C that becomes long-term stabilized. Deep soil C is stored for centuries or millennia, in contrast to C stored in vegetation, topsoils, or via other C sequestration strategies. We hypothesize that the soil C sink could be enhanced (e.g. in marginal and agricultural soils) via a greater emphasis on crops with deep rooting phenotypes such as switchgrass, *Panicum virgatum*.

Analyses were conducted in field plots planted with 'high' and 'low' performing switchgrass (Alamo cultivar) genotypes. Field sites are at the Nobel Research Institute's Red River Farm near the OK-TX border (sandy loam soil, low in NO<sub>3</sub>-N and organic matter), and the 3rd Street Farm in Ardmore TX (silt loam soil, low in available P). Using a 'whole root ball' harvest approach, we measured root biomass and architecture for both high and low performing plants, as well as root elemental chemistry, sugar and protein content and overall digestibility. We compared this massively labor-intensive approach to a geospatial coring approach, and also a Tomographic Electrical Rhizosphere Imaging (TERI) approach designed to provide high throughput, dynamic, in-situ root phenotyping. Using accelerator mass spectrometry <sup>14</sup>C analyses of 2 m deep soil profile samples from our switchgrass fields, we characterized soil C stocks and turnover time prior to planting, and in several years' time will compare this to analogous in-plot measurements to assess C accrual. We also established a capability to make deep *in situ* <sup>14</sup>CO<sub>2</sub> measurements to assess the radiocarbon age of actively respired carbon and have measured <sup>14</sup>C on soil density fractions to quantify soil C distribution and turnover of particulate, aggregate occluded, and mineral-associated C pools. Samples for analysis of microbial community

composition (16S rRNA and ITS) were also collected with depth and are currently being processed.

We found significant variation between high- and low-performing genotypes for root, shoot, and crown weight across locations with better shoot and crown growth in 3rd street but root growth in Red River. Root biomass was higher in high performing genotypes and in sandy soils, and better measured by the direct approach than inferences based on coring. Total soil C and N stock decline precipitously with depth, and soil carbon is primarily found in the mineral associated fraction beyond the top 20 cm. Soil carbon turnover time ranged from ~3000 yrs in silt loam soils to >4000 yrs in sandy soils.

*This research is based upon work supported by the U.S. Department of Energy Office of Science, Office of Biological and Environmental Research Genomic Science program under Award Number DE-SC0014079 to the UC Berkeley, Noble Research Institute, the University of Oklahoma, the Lawrence Livermore National Laboratory and the Lawrence Berkeley National Laboratory. Part of this work was performed at Lawrence Berkeley National Lab under contract DE-AC02-05CH11231 and at Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344.*