# Unlocking plant-microbial interactions in deep soils: Linking depth gradients in roots, microbial activity, and soil carbon

Brzostek, Edward R.; West Virginia University; erbrzostek@mix.wvu.edu
Pagliaro, Zoe; West Virginia University; zep00003@mix.wvu.edu
Mathias, Justin; West Virginia University; justin.mathias@mail.wvu.edu
Morrissey, Ember; West Virginia University; ember.morrissey@mail.wvu.edu

## Abstract

Growing deep-rooted plants may offer the potential to build soil carbon (C). However, most research has focused on shallow soils. This focus on shallow soils neglects deep soils which account for at least a third of all soil C. Thus, our objectives were to: (1) link depth gradients in root biomass with microbial activity and soil C stocks down to 1 meter and (2) examine differences between depths in the ability of simple C inputs, as a proxy for root exudates, to prime or build soil C. For a model system, we used the deep-rooted perennial bioenergy crop, Miscanthus, which has been shown to build soil C in the top 30cm. To meet our objectives, we dug five, quantitative soil pits under 20-year-old Miscanthus plots in Champaign-Urbana, IL. We excavated soils from a 1m x 30 cm x 1m volume and separated them into five depths. Observationally, we measured fine root biomass, total soil C, mineral associated organic C (MAOC), particulate organic C (POC), microbial respiration, net nitrogen cycling, and enzyme activity. Experimentally, we added $^{13}C$ labeled glycine to soils from each depth in a lab incubation and followed the fate of the carbon into different soil C fractions.

We found strong significant declines with depth in fine root biomass, total soil C, MAOC, POC, and microbial activity. POC declined more rapidly with depth than MAOC leading to an increase in the ratio of MAOC-to-POC. When we examined linkages between total soil C and root and microbial measurements, we found that fine root biomass, n-acetyl-glucosaminidase (NAG) activity, and microbial respiration explained 98% of the variability in soil C. Both fine root biomass, representing inputs, and NAG, representing microbial recycling of dead cell walls, had positive effects on soil C. By contrast, microbial respiration had a negative effect. MAOC mirrored these results, but POC was only dependent on fine root biomass. In our experiment, we found that all depths had similar ability to transfer simple C inputs into MAOC. However, this transfer led to net MAOC losses in shallow soils, and net MAOC gains in deep soils. Collectively, these results suggest that soil C represents a balance between inputs, decomposition, and the recycling of microbial necromass. Moreover, in deeper soil horizons with low decomposition rates, increases in root C inputs may have the potential to build soil C.