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Incorporated switchgrass leaves and roots and their contributions to CO_2 and N2O emissions in soil with contrasting pore size distributions

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Soil microsites where newly added plant residue undergoes decomposition are the hotspots of microbial activity, due to microbial utilization of organic matter as their energy sources. Thus those sites often contribute to high emission of greenhouse gases such as carbon dioxide (CO_2) and nitrous oxide (N_2O). Although it is known that microbial activity and decomposition are regulated by residue's chemistry, residue's interactions with soil physical characteristics have been less understood. Specifically, soil pore size distributions could also alter the degree/type of microbial activity by regulating soil water and air pathways, including O_2 levels. In the past most of the plant residue incorporation studies focused on agronomic crops, while the crops that are currently proposed as feedstock for bioenergy production received less attention. For example, switchgrass is considered as one of the sustainable bio-energy crops due to its high yield, low input, and positive impact on soil and water conservation during the growth. Studying decomposition of switchgrass would allow us to assess its environmental impact more thoroughly. Thus, the goal of this study is to: 1) investigate the rate of decomposition for switchgrass leaf and root residues incorporated into soil with contrasting pore characteristics; 2) monitor CO_2 and N2O fluxes from the soil with incorporated residue during the decomposition; and 3) monitor O_2 levels and spatial patterns of extracellular enzymes during decomposition.

We built soil microcosms (d = 8 mm) with 2 g of soil and 2 mg of residue using soil materials with contrasting pore size distributions, namely with prevalence of $<$ 10 um and $>$ 30 um pores. CO_2 and N_2O emission rates were measured during 21-day incubation, and computed micro-tomography was used to quantify residue decomposition at 7, 14, and 21 days of incubation and moisture redistribution after the incorporation of plant residues. Additionally, oxygen micro-sensors and zymography technique will be applied to examine the O_2 and enzyme distributions (ongoing).

Preliminary results showed that overall CO_2 and N_2O emissions were greater in soil with prevalence of $<$ 10 um pores rather than $>$ 30 um pores. However, presence of residues led to greater increases in N_2O emissions from the soil with prevalence of $>$ 30 um pores than in that with $<$10 um pores. The increases of CO_2 emissions due to the residue inputs were not significantly different among the two pore size treatments. The peak N_2O emission in control soil was reached on day 1, but peak emissions occurred on day 3-5 in the presence of residues. Greater residue decomposition took place in the soil of $>$ 30 um than in $<$10 um pore treatments. There were no significant differences in CO_2 / N_2O emissions between switchgrass root and leaf residues.