Geophysical Research Abstracts
Vol. 18, EGU2016-11550, 2016
EGU General Assembly 2016

Soil organic matter content: a non-liner control on microbial respiration in soils

Jörg Schnecker and Stuart Grandy

University of New Hampshire, Department of Natural Resources and the Environment, Durham, United States (joerg.schnecker@unh.edu)

It is widely assumed that microbial activity and respiration rates respond linearly to substrate concentrations, irrespective of substrate chemical characteristics, but this assumption remains largely untested. We know that microbial decomposition of soil organic matter (SOM) and the amount of CO_2 respired from soil depends on substrate availability. While soils with high SOM concentrations will have higher respiration rates than soils with low SOM concentrations, the specific relationship between substrate quantity and CO_2 respired and its underlying mechanisms has robust theoretical, modeling, and management implications.

In a lab incubation experiment, we amended a mixture of agricultural soil and sand with increasing amounts of one of three plant residues differing in their C/N ratio (clover C/N 14; rye C/N 23 and wheat straw C/N 110). Keeping the soil/sand mixture at a constant ratio, we obtained 9 levels of organic carbon (OC) content ranging from 0.25% to 5.7%. The sand-soil-residue mixtures were then incubated at constant temperature and water contents for a total of 63 days.

Our results show that across substrates CO_2 production increased with increasing OC content following a sigmoidal curve function instead of the expected linear one. A breakpoint analysis for the respiration curve of rye revealed two significant break points at 1.3 and 3.8 % OC. The three individual linear relations might be shaped by spatial separation of substrate and microbes and the interaction of the microbes themselves. In the first "survival" phase up to 1.3 % OC, more substrate leads to the survival of more microbes. However, microbial growth does not result in the discovery of new resources. In the "expansion" phase (1.3 % OC to 3.8 % OC), microbial growth is successful and microbes can exploit new resources. Finally, in the "competition" phase microbes start to compete for space and resources, which leads to a decrease in decomposition and respiration.

While the results for clover were similar to rye, different amounts of straw resulted in an almost linear relationship between OC content and respiratory loss. The low N content of straw may explain this, limiting microbial growth and the exploration for new resources. Microbes in the straw treatment likely remained in the "survival" phase.

Our findings of a non-linear decrease of CO_2 production with decreasing OC content indicate that spatial separation as an inherent property of SOM content is an important control on decomposition of soil organic matter. Knowledge of this controlling effect might be beneficial in many ways. For example, even small additions of plant residues to agricultural systems might strongly enhance N availability to microbes and plants. Further, the spatial distribution of new C inputs may regulate its potential to be decomposed or stabilized. Finally, our results will help to improve model parameterization and predictions about microbial limitations and potential changes in decomposition under a future climate.