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Spatial and temporal microscale pH change at the soil-biochar interface

Wolfram Buss[1], Jessica G. Shepherd[1,2], Kate V. Heal[2], Ondřej Mašek[1]
[1]UK Biochar Research Centre, School of GeoSciences, University of Edinburgh, Edinburgh, UK
[2]School of GeoSciences, University of Edinburgh, Edinburgh, UK

Abstract:

Soil pH is a crucial factor for soil fertility and agronomic performance. It is generally accepted that biochar's ability to increase soil pH explains much of its positive effect on plant growth. Yet, very little is known and, to our knowledge, no publication exists regarding biochar's influence on pH locally at the biochar particle scale and how this changes with time. Because biochar is a heterogeneous material and can be made from different feedstocks, it is crucial to investigate the biochar-specific effects on soil pH. In this study, a non-invasive technique (planar optode) capable of continuous measurement of pH on the micrometre scale was used to monitor pH changes in biochar-amended soil. Two biochars (sewage sludge 550 °C (SWSS 550) and Miscanthus straw 700 °C (MSP 700)) of contrasting pH (6.75, 9.72) were applied to an acidic sandy soil (pH 4.9 in CaCl2) and the pH at the soil/biochar interface was measured over a 21-h period. After 21 h the pH in soil amended with SWSS 550 and MSP 700 was optimal for maximum soil fertility (≥ 5.4) in an area around the biochar particle extending to ~ 1 and ~ 1.3 times the biochar particle diameter from its surface, respectively. These results demonstrate the greater potential of MSP 100 for increasing soil pH, which is confirmed by calcium carbonate equivalent measurements. Planar optode technology can help us better understand pH changes at the biochar-soil interface and enables the production of biochars optimised for improving soil pH and delivering nutrients in different soils.

Keywords: Planar optode, nutrients, availability, sewage sludge, Miscanthus