Geophysical Research Abstracts
Vol. 16, EGU2014-11429, 2014
EGU General Assembly 2014

Impact of pyrogenic organic matter decomposition and induced priming effect on soil C budget.

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Pyrogenic organic matter (PyOM) results from the incomplete combustion of biomass and may contribute to constitute an important fraction of soil C in forest and agricultural soils, in the form of charcoal (produced by wildfires) or biochar (anthropogenic). Although many evidences exist on the long mean residence time of PyOM there is still a large uncertainty on PyOM loss processes and rate and on possible induced priming effect on non-PyOM. Therefore determining PyOM mineralization rate, loss processes and possible induced priming effect on soil organic matter decomposition are key issues to understand the impact of PyOM on the carbon (C) cycle.
We investigated the impact of PyOM on soil C budget by combining results from three independent studies: (i) a field study to investigate PyOM mineralization rate and the relative importance of PyOM loss processes, (ii) a PyOM and soil incubation experiment to correlate C and N mineralization rates, (iii) a review of the priming effect induced by PyOM on soil organic C.
We employed 13C labelled pinewood-derived PyOM for the field experiment and 13C labelled ryegrass-derived PyOM in the incubation experiment to trace PyOM losses.
In the field experiment it was observed that: (i) Pyrolysis process reduced pinewood decomposition by a factor of 60, (ii) leaching and translocation of fresh PyOM along the soil profile were negligible compared to losses as CO_2. In the incubation experiment we found that ryegrass induced a two phase priming effect on native soil organic matter, with a positive priming effect followed by a negative priming effect phase, we also found that ryegrass-derived PyOM decomposition was much slower than pinewood one. The different decomposition rate results probably from the different aromaticity of the two PyOM together with the different set-up of the two experiments.
Both the incubation experiment and the meta-analysis revealed that PyOM may induce a two-phase priming effect on native soil organic matter decomposition: positive on the short term and negative on the long term. The meta-analysis showed that that positive priming effect is induced mostly on the native soil organic matter on the short term and by PyOM characterised by a low C content. This result was not confirmed on the freshly added organic matter. We believe that the presence of a labile fraction in PyOM may induce positive priming effect on the short term by mean of co-metabolism.
We conclude that PyOM chemical composition and feedstock play an important role in predicting PyOM mineralization rate, and that on the short term PyOM may induce a positive priming effect therefore decreasing the abatement potential of PyOM as a C-sink.