Geophysical Research Abstracts
Vol. 18, EGU2016-3421, 2016
EGU General Assembly 2016

Unexpected stimulation of soil methane uptake by bio-based residue application: An emerging property of agricultural soils offsetting greenhouse gas balance.

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Intensification of agriculture to meet the global food, feed, and bioenergy demand entail increasing re-investment of carbon compounds (residues) into agro-systems to prevent decline of soil quality and fertility. However, agricultural intensification decreases soil methane uptake, reducing and even causing the loss of the methane sink function. In contrast to wetland agricultural soils (rice paddies), the methanotrophic potential in well-aerated agricultural soils have received little attention, presumably due to the anticipated low or negligible methane uptake capacity in these soils. Consequently, a detailed study verifying or refuting this assumption is still lacking. Exemplifying a typical agricultural practice, we determined the impact of bio-based residue application on soil methane flux, and determined the methanotrophic potential, including a qualitative (diagnostic microarray) and quantitative (group-specific qPCR assays) analysis of the methanotrophic community after residue amendments over two months. Unexpectedly, after amendments with specific residues we detected a significant transient stimulation of methane uptake confirmed by both the methane flux measurements and methane oxidation assay. This stimulation was apparently a result of induced cell-specific activity, rather than growth of the methanotrophic population. Although transient, the heightened methane uptake offsets up to 16% of total gaseous CO_2 emitted during the incubation. The methanotrophic community, predominantly comprised of Methylosinus spp. may facilitate methane oxidation in the agricultural soils. Studies are under way to identify the active methane-oxidizers at near atmospheric methane concentrations using PLFA-Stable isotope probing (SIP). While agricultural soils are generally regarded as a net methane source or a relatively weak methane sink, our results show that the methane oxidation rate can be stimulated, leading to higher soil methane uptake. Moreover, the addition of some residues also increased crop (common wheat; Triticum aestivum) yield. Hence, even if agriculture exerts an adverse impact on soil methane uptake, implementing carefully designed management strategies (e.g. repeated application of specific residues) may compensate for the loss of the methane sink function, while increasing crop production following land-use change.