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How Residues of Differently Aged *Calliandra calothyrsus* Shape the Abundance of Soil Nitrifying Prokaryotes

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Abstract

The use of leguminous organic residues in resource-prone smallholder farming systems is widely acknowledged. A central knowledge gap remains, however, to what extent a change of biochemical quality (e.g. C/N ratio, ([polyphenol+lignin]/N (PP+L/N) ratio) of organic inputs as result of increasing age of the same plant species shapes the abundance of soil nitrifying microbes (i.e. ammonia-oxidising bacteria (AOB) and archaea (AOA)). The aim was thus to assess age effect reflected in differences in biochemical quality of organic inputs, on the abundance of amoA gene copies (AOA and AOB) during the initial stages of decomposition. Organic inputs from leguminous *Calliandra calothyrsus* (10 ton ha^{-1} dry weight) of different age (i.e. <3 years; C/N ratio 13.1; PP+L/N: 2.95, >5 years; 18.2, 3.02) were mixed with two soils from Ethiopia (pH 4.3; TC 2.32; TN 0.15) and DR Congo (pH 5.1; TC 3.52; TN 0.29). A control treatment without residues was included. Soil samples were obtained at 7, 15, 30, 45 and 60 days after residue application. Samples were analysed for amoA gene copies for AOA and AOB as well as for total bacterial and archaeal 16S rRNA gene copies using quantitative PCR. Generally, under the young Calliandra, increasing of gene copy numbers ($p < 0.001$) of AOA and AOB ($p < 0.01$) were observed. Input type and incubation time showed a significant interaction for AOB abundance ($p < 0.01$), which increased from day 7 to 45. N-NO_3, NH_4^+ and DON concentration was correlated with AOA (r=0.76, $p < 0.0001$; r=0.42, $p < 0.0001$; r=0.75, $p < 0.0001$ respectively), and AOB (r=0.58, $p < 0.0001$ r=0.25, $p < 0.01$; r=0.57, $p < 0.0001$) abundance throughout the incubation. The study demonstrated that the abundance of nitrifying prokaryotes was influenced by biochemical quality of residues obtained from differently aged Calliandra, which was mainly attributed to the increase in amoA gene copies of AOA and AOB under young Calliandra, a phenomenon that may be explained by the low C/N and PP+L-N ratios. Results showed that the assessed change of biochemical quality of organic inputs is a determinant of the abundance of soil nitrifying microbes and has to be considered when using contrasting organic residues for adapted soil fertility management in resource-prone smallholder agricultural systems.

Keywords: 16S Archaea, 16S Bacteria, AOA, AOB, residue quality

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