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“Development on the margin”

A Microcosm Experiment to Assess Microbial Process as Determined by Different Biochemically Organic Residues

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Abstract

Biochemical composition of organic residues whose quality is partly defined by their content of organic N (Norg), and polyphenols (PP), influences the accumulation of soil organic matter (SOM) and the still poorly understood soil microbial decomposition processes. A better understanding of these microbial processes, through the study of microorganisms involved in residue decomposition and their functional attributes, is crucial to maintain soil productivity in tropical ecosystems. To provide complementary information on how organic residue quality influences soil microbial properties, we reverted to a long-term field experiment in Thailand in which the effects of biochemically different organic residues such as rice straw (RS; Norg content: 4.7; PP content: 6.5 g kg⁻¹), groundnut (GN; 22.8; 12.9), tamarind (TM; 13.6; 31.5), and dipterocarp (DP; 5.7; 64.9) on SOM dynamics are studied since 16 years. It was of particular interest how microbial processes in soils which have received these residues since 16 years (native soils, N-soil) were altered as compared to those that did not receive any residue material during the same period (control soil; C-soil). Soils were taken from the field experiment and incubated in microcosms with the following treatments: N-soil was mixed with either residue (e.g. N-soil treated with RS since 16 years plus fresh RS (NRS+RS), NGN+GN, NDP+DP, NTM+TM) or left untreated (NRS, NGN, NDP, and NTM), while C-soil was mixed with either residue (C+RS, C+GN, C+DP, and C+TM) or left untreated (CON). After 56 days incubation, soils were analysed for soil microbial biomass carbon (MB-C) and its function (cumulative carbon dioxide evolution (CO₂-C) as well as activities of invertase, β -glucosidase and phenoloxidase. Results showed that MB-C, CO₂-C, as well as activities of invertase and β -glucosidase in residue treated N-soils tended to be higher than those in residue-treated C-soils, while the opposite was found for phenoloxidase activity. The effect of residue quality was most pronounced for residue-treated C-soils in which phenoloxidase showed highest activity after DP addition, while activities of invertase and β -glucosidase were promoted in TM- and GN-treated N-soils. These results indicated that 16 years of continuous residue addition led to a general increase of soil microbial processes in N-soils, but the most obvious residue quality effect was determined for microbial polyphenol oxidation in C-soils treated with DP, probably because of its high polyphenol content. We could prove that long-term addition of biochemically different residues shaped soil microbial processes, but it still needs to be elucidated why C-soils showed a similar reaction like the N-soils and why polyphenol oxidation appeared to be particularly pronounced. For further investigation, we will apply molecular techniques to identify those specific microbial community members actively involved in polyphenol oxidation.

Keywords: Long-term field experiment, organic residue quality, soil microbial processes