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Linking litter quality to microbial community structure and functioning in an agricultural soil

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Anthropogenic pressures on agricultural soils are known to alter their biodiversity, which may affect the capacity of ecosystems to deliver functions and services according to the insurance hypothesis on diversity – function relationship. Cropping systems is fuelling belowground biota through the quality of litter supplied, which varies in quality from year to year. Therefore we hypothesized that soil biota structure and functioning strongly respond to crop residues quality. Aerial and underground parts of maize plants were used as labile and recalcitrant litter, respectively. A dynamic experiment was performed using soil columns filled with a silty loam agricultural soil (Estrées-Mons, Northern France) in which we incorporated in the 0-5cm layer either maize leaves or maize roots (and a control treatment without litter). We measured regularly soil respiration, litter quality, enzyme activities, microbial biomass, bacterial and fungal community structure (using 16S and 18S pyrosequencing) during the incubation period.

Litter quality strongly influenced degradation rates of litter soluble fraction and polysaccharides, leading to faster C mineralization of maize leaves compared to roots. Enzyme efficiency was higher in the recalcitrant litter demonstrating different microbial strategies. After 15 days of decomposition, leaves stimulated the relative proportion of Proteobacteria and Bacteroidetes (classified as copiotrophic bacteria by Fierer et al. 2007). Similarly in the fungal community, Tremellomycetes and Sordariomycetes exhibited the most copiotrophic behavior. General functions such as soluble compounds mineralization rates were better correlated with microbial biomass ($R^2=0.65$) than with community structure. Nevertheless, more specific functions such as complex C forms degradation were related to bacterial community structure. We concluded that the decomposition of complex C forms, having a high energetic cost for microorganisms, strongly impacts the community structure. Thus, ecosystem functioning depends on biota community structure linked to the resources provided to them.

Keywords: Litter quality, Microbial communities, Enzymatic activities, pyrosequencing