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The specific role of fungal community structure on soil aggregation and carbon sequestration: results from long-term field study in a paddy soil

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Soil aggregate stability is a crucial soil property that affects soil biota, biogeochemical processes and C sequestration. The relationship between soil aggregate stability and soil C cycling is well known but the influence of specific fungal community structure on this relationship is largely unknown in paddy soils. The aim of the present study was to evaluate the long-term fertilisation (mineral fertiliser-MIN; farmyard manure-FYM; groundnut oil cake-GOC) effects on soil fungal community shifts associated with soil aggregates under rice-monoculture (RRR) and rice–legume–rice (RLR) systems. Fungal and bacterial communities were characterized using phospholipid fatty acids, and glucosamine and muramic acid were used as biomarkers for fungal and bacterial residues, respectively. Microbial biomass C and N, fungal biomass and residues were significantly higher in the organic fertiliser treatments than in the MIN treatment, for all aggregate sizes under both crop rotation systems. In general, fungal/bacterial biomass ratio and fungal residue C/bacterial residue C ratio were significantly higher in macroaggregate fractions (> 2000 and 250–2000 μm) than in microaggregate fractions (53–250 and <53 μm). In both crop rotation systems, the long-term application of FYM and GOC led to increased accumulation of saprotrophic fungi (SF) in aggregate fractions > 2000 μm. In contrast, we found that arbuscular mycorrhizal fungi (AMF) was surprisingly higher in aggregate fractions > 2000 μm than in aggregate fraction 250-2000 μm under MIN treatment. The RLR system showed significantly higher AMF biomass and fungal residue C/ bacterial residue C ratio in both macroaggregate fractions compared to the RRR system. The strong relationships between SF, AMF and water stable aggregates shows the specific contribution of fungi community on soil aggregate stability. Our results highlight the fact that changes within fungal community structure play an important role in shaping the soil aggregate stability and C sequestration in tropical agricultural ecosystems.