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Effect of a biological additive associated with mineral fertilizer on soil microbiota and plant growth under different management systems

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The efficiency of mineral fertilizers can be influenced by interactions with soil microbiota. However, responses depend on soil type and management history. In this study, we evaluated, in a greenhouse experiment, the effects of a mineral fertilizer with a biological additive (FA) on plant growth and bacterial and fungal microbiota across soils from different management systems (conventional, native forest, crop rotation, pasture), compared with mineral fertilizer (FSA) and a control (CT), using diversity, composition, Networks, and Random Forest analyses. FA promoted gains in plant biomass and nutrition in most soils, with a strong response in crop rotation, where increases of up to 14.5% in shoot dry mass, 7.15% in height, and 3.69% in diameter were observed, along with increases of 8.4% in phosphorus and 17.1% in sulfur relative to FSA. The microbial community was strongly structured by soil type, while treatment effects were subtle. For bacteria, alpha diversity remained stable, but composition varied in key taxa, including *Bacillus* (conventional), *Pseudomonas* (native forest), *Rubrobacter* and *Fusarium* (pasture), and *Novosphingobium* (crop rotation). Random Forest showed treatment separation is mainly driven by indicator genera rather than global community shifts. Bacterial networks showed higher complexity in native forest and greater sensitivity in pasture. FA increased network connectivity in all soils, suggesting stronger microbial interactions. For fungi, higher structural stability was observed, with dominance of Ascomycota and Basidiomycota and no changes in alpha or beta diversity. Shifts were restricted to specific genera, with an increase in *Aspergillus* and *Clonostachys*. Fungal networks varied by soil type, being more complex in native forest and pasture and more fragmented in crop rotation. Overall, results indicate the biological additive associated with mineral fertilizer promotes consistent responses and modulates the microbiota mainly at the level of indicator taxa and microbial interactions, while community structure is primarily determined by soil type.

KEYWORDS: Microbiome, Co-occurrence networks, Random Forest, Soil fertility

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