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Long-term fertilization strategies change soil property and fungal community composition in Chinese Mollisols

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How fungi function as sensitive indicators of soil fertility in Chinese Mollisols has received limited attention. To broaden our knowledge, we used high-throughput pyrosequencing and quantitative PCR to explore the responses of soil fungal community to long-term chemical and organic fertilization strategies. Soils were collected in a 35-year field experiment with four treatments: no fertilizer, chemical phosphorus and potassium fertilizer (PK), chemical phosphorus, potassium and nitrogen fertilizer (NPK), and chemical phosphorus and potassium fertilizer plus manure (MPK). All fertilization strategies significantly changed soil properties and increased soybean yields, with the highest yield occurring under the MPK regime. The MPK application benefited soil acidification alleviation and organic matter accumulation. Moreover, ITS gene copies decreased under the MPK regime, leading to an increased bacteria-to-fungi ratio, while the chemical fertilization application exhibited the opposite pattern. The MPK application might be beneficial for the resilience of microbial diversity and stability owing to the high community richness indices (Chao1 and ACE). The phylum Ascomycota was dominant in all samples, followed by Zygomycota, Basidiomycota, Chytridiomycota and Glomeromycota. At each taxonomic level, the community composition dramatically differed under different fertilization strategies, leading to different soil quality. The NPK application caused a loss of plant–fungal symbioses, nitrogen losses in soil and greenhouse gas emissions due to the shifts in the classes Leotiomycetes and Eurotiomycetes. Furthermore, NPK promoted fungal taxa with known pathogenic traits, such as the order Chaetothyriales, family *Chaetothyriaceae*, and genera *Corynespora*, *Bipolaris*, *Pleosporaceae* and *Cyphellophora*. In contrast, under the MPK regime these fungi existed at low levels. Soil organic matter and pH were the two most important contributors to fungal community. In conclusion, the responses of fungal community composition to long-term fertilization strategies were determined, and the potential of organic manure as a substitute for chemical nitrogen fertilizers in sustainable agriculture was highlighted.