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长期施肥对黑土农田土壤微生物群落的影响

Effect of long-term fertilization on soil microbial communities in farmland of black soil

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中文摘要:

基于中国科学院海伦农业生态试验站长期定位试验区，应用实时荧光定量PCR（Real-time PCR）和变性梯度凝胶电泳（DGGE）技术研究了无施肥（NF）、单施N、P化肥（NP）以及化肥配施有机猪粪肥等3种长期施肥措施对黑土区玉米田土壤微生物群落密度和结构的影响。Real-time PCR方法定量NF、NP及NPM措施土壤细菌群落基因组DNA质量分别为381、1351和1773 ng g^{-1}干土，真菌群落基因组DNA质量分别113.3、127.3和20.6 ng g^{-1}干土，真菌与细菌的比率分别为0.31、0.09和0.01，NPM措施显著低于另两种施肥方式（$p<0.05$）。DGGE方法研究表明，NP和NPM措施不能改善土壤细菌和真菌群落的多样性、均匀性及优势菌优势程度；但主成分分析结果显示NP和NPM措施均可改变土壤细菌和真菌群落的构成，且真菌群落的变化更为显著；聚类分析结果显示NP和NPM措施下细菌群落结构较相近，其相似系数为0.89，真菌群落中NP措施与NF措施相近，相似系数为0.63，高于NP与NPM措施的相似系数0.51。上述结果表明有机猪粪肥的长期施用可以显著降低黑土农田土壤真菌与细菌的比率，且明显地改变土壤细菌和真菌群落的结构。

Abstract:

Using real-time PCR and denaturing gradient gel electrophoresis (DGGE), effects of long-term fertilization on densities and structures of the soil microbial communities in corn fields of black soil were determined. The corn fields were located at the Hailun Experimental Station of Agricultural Ecology in Northeast China and had been under a long-term fertilization experiment designed to have 3 treatments, i.e. NF (no fertilizer), NP (chemical fertilizers nitrogen and phosphorus), and NPM (chemical nitrogen and phosphorus combined with pig manure). In real-time PCR analyses, the total genomic DNA of the microbial community in treatments NF, NP and NPM was found to be 381, 1351 and 1773 ng per gram of soil, and of the fungal community, 113.3, 127.3 and 20.6 ng respectively. Fungi to bacteria ratio in the 3 treatments was 0.31, 0.09 and 0.01, separately. Obviously Treatment NPM is lower than Treatments NF and NP in this aspect ($p<0.05$). Analysis of the DGGE indices shows that Treatments NP and NPM did not improve the soil microbial communities in diversity, uniformity and dominance of dominant microbes. However, according to principal component analysis, these two treatments altered the structures of the soil bacterial and fungi communities, especially the latter. Meanwhile, the tree clustering analysis indicates that the bacterial community structures in Treatments NP and NPM were quite similar, being 0.89 in similarity coefficient. But for the fungal community, its structure in Treatment NP is more similar to that in Treatment NF, with similarity coefficient being 0.63, which is higher than 0.51 between Treatments NP and NPM. All above findings indicate that the long-term fertilization using organic fertilizer (pig manure) could significantly decrease the fungal to bacterial ratio and alter the soil bacterial and fungal community structure in the filed.