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长期定位施肥对石灰性紫色水稻土古菌群落结构的影响

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Effect of long-term fertilization on archaeal community structure in calcareous purplish paddy soil

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摘要 为了认识长期施肥对石灰性紫色水稻土培肥和肥力演化的作用, 结合变性梯度凝胶电泳(denaturing gradient gel electrophoresis, DGGE)和限制性酶切片段长度多态性(RFLP)技术, 研究了稻麦轮作下农家肥(M)、氮肥+农家肥 (NM)、氮磷肥+农家肥(NPM)、氮磷钾肥+农家肥(NPKM)、无肥(CK)、氮肥(N)、氮磷肥(NP)、氮磷钾肥(NPK)等不同施肥制度对石灰性紫色水稻土古菌群落结构的影响。研究结果表明, 长期定位施肥明显影响土壤中的古菌组成。在长期施用氮肥+农家肥、氮磷肥和氮磷钾肥+农家肥处理的土壤中, 古菌多样性指数低于农家肥、氮磷肥+农家肥、无肥、氮肥和氮磷钾肥处理。在DGGE图谱的基础上, 分别选择种植水稻和小麦的氮磷钾肥处理土壤样品, 对古菌克隆子的16S rDNA序列进行了系统发育分析, 发现水稻土古菌与各种土壤及水体环境的古菌极其相似。对DGGE图谱的聚类分析发现, 不管是种植水稻还是小麦, 8种施肥处理的古菌都聚在3个群里。种植水稻时, M和NPK处理下的土壤古菌聚成第一个群, NP处理下的聚成第二个群, 另外5种施肥处理(NPKM, NM, CK, N 和NPM)聚成第三个群。种植小麦时, NPKM和M处理下的土壤古菌聚成一个群, NP处理下的聚成第二个群, N、NPK、NM、NPM和CK处理下的聚成第三个群。聚类分析结果显示, 作物类型会影响土壤古菌群落结构。

关键词: 施肥制度 DGGE RFLP 古菌群落

Abstract: To better understand the role that fertilization systems play in soil fertility buildup and evolution, we employed denaturing gradient gel electrophoresis (DGGE) and restriction fragment length polymorphism (RFLP) to determine the influence of different fertilization treatments on archaeal community structure in calcareous purplish paddy soil under rice/wheat rotations. The eight fertilization treatments were as follows: manure only (M), nitrogen plus manure (NM), nitrogen and phosphorus plus manure (NPM), nitrogen, phosphorus and potassium plus manure (NPKM), without fertilization (CK), mineral nitrogen (N), nitrogen-phosphorus (NP) and nitrogen, and phosphorus and potassium (NPK). Our results showed that long-term fertilization significantly affected soil archaeal community structure; the richness and diversity of archaeal community under NM, NP and NPKM were lower than those under the other fertilization treatments (M, NPM, CK, N, and NPK). Based on the DGGE patterns, two soil DNA samples isolated from the NPK-amended soil were used for RFLP analysis of archaea. Phylogenetic analyses showed that archaea in the calcareous purplish paddy soil was highly diverse, and the sequences were closely related to those archaeal sequences isolated from various soils and water environment. Cluster analysis of the DGGE profiles showed that archaeal communities under the eight fertilization treatments clustered into three groups. In soil from paddies currently under rice cultivation, the archaeal communities in the soil amended with M and NPK grouped into the first cluster, while NP was in the second group, and NPKM, NM, CK, N and NPM were in the third. In the soil with wheat cultivation, NP-treated archaeal communities clustered into a cluster, NPKM and M were in the second cluster, and N, NPK, NM, NPM and CK soil communities comprised the third cluster. The cluster analysis showed that crop type impacts the community structure of soil archaea.

Keywords: fertilization system DGGE RFLP archaeal communities

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