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Residue Quality and Agro-Ecological Effect of Microbial Prokaryotes Abundance in Agricultural Soils; Ethiopia and DRC

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Abstract

Microbial communities have been acknowledged to play major role in geochemical cycling of soil nutrients in agricultural systems. Organic residue management has been reported to improve soil fertility, enhance soil productivity and quality. However, effects of biochemical quality such as C/N ratio and complex compounds (phenols (P), lignin (L) and cellulose (CL)) of legumes (*Leucaena leucocephala* (LL), *Calliandra calothyrsus* (CC) and *Acacia decurrens* (AD)) on the abundance of total (bacterial and archaeal 16SrRNA genes) and nitrifying (bacterial and archaeal amoA genes) microbial communities under different agro-ecologies is still unknown. The objective of this study was to investigate the response of bacterial and archaeal 16SrRNA and amoA gene abundance to biochemical quality (C/N ratio, phenols, lignin, cellulose) of different perennial residues during decomposition. Residues of LL (C/N ratio (11.61), L (1.71), CL (12.54), P (12.08)) and AD (C/N ratio (23), L (13.57), CL (16.73), P (15.09)) were incorporated in fields of Ethiopia (Injebara and Koga) and LL (C/N ratio (4.96), L (10.63), CL (9.2), P (9.11)) and CC (C/N ratio (13.84), L (14.86), CL (12.28), P (11.4) in DRC (Mushinga and Murhesa). Soil samples were subjected to quantitative PCR analysis; copy numbers of target genes were measured for all residue treatments. Results showed an interactive effect of both residue quality and agro-ecology on archaeal 16SrRNA ($p < 0.001$) with AD recording higher copy numbers under relatively stable soil moisture conditions. This interaction also had an effect on archaeal 16SrRNA and bacterial amoA genes ($p < 0.05$) in DRC. Over time, in Ethiopia, residue quality showed an effect on total 16SrRNA (bacterial & archaeal) and archaeal amoA genes ($p < 0.05$) but not on bacterial amoA ($p > 0.05$). For DRC, a time-residue quality interaction was observed for all investigated genes ($p < 0.05$). The findings of this study indicate that both residue quality and agro-ecology have an effect on abundance of archaeal 16SrRNA and amoA genes (bacterial and archaeal) for both countries. This might be attributed to lignin and C/N ratio differences of residues and agro-ecology (temperature and rainfall differences). Further studies should include more samples and sampling times to give a more conclusive result.

Keywords: Agro-ecology, gene abundance, organic residue quality