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Effect of Fertilizer-P application on the relative abundance of nitrogen cycle genes in a phosphorus limited paddy soil from subtropical region

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The addition of phosphorus to P-limited soils has been shown to cause a marked increase in the loss of gaseous N. The reasons for this remain unclear but linked nutrient cycling in the rhizosphere (C:N:P) leading to enhanced nitrification and denitrification have been proposed. We investigated the impact of adding P to P-limited soils on the dynamics of soil N-cycle functional genes. Rice seedlings were planted in P poor soils and incubated under different water conditions with or without P application. The abundance of ammonia-oxidizing bacteria and archaea in the rhizosphere and bulk soil were quantified by Real Time PCR (qPCR) using amoA gene abundance. Results showed that P addition resulted in a decrease in soil NH4+ content and a reduction in the the abundance of ammonia-oxidizing bacteria (AOB). There was little measurable effect on ammonia-oxidizing archaea (AOA). As expected from the marked increase in gaseous N loss, the relative abundances of the four functional genes (narG nirK, nirS, nosZ) increased following P application. This is thought to be a consequence of reducing the impact of P limitation on denitrifying bacteria in the bulk soil. The experimental design used allowed us to deteremine whether the gene responses to P addition in the rhizosphere (where the molar ratios of C:N:P were expected to differ) were different from those of the bulk soil. This ‘rhizosphere effect’ was weakened for ammonia oxidizing functional genes and enhanced for denitrifying funcational genes by P application, resulted in a greater abundance of AOB (amoA gene) and lower amounts of nirK, nirS and nosZ in rhizosphere soil. The work reported here shows the impact of available P in regulating gaseous N loss from soil and demonstrates the importance of stoichiometry and balanced nutrient availability on the fertilization and management of agricultural soils.