Dissimilatory nitrate reduction to ammonium, denitrification and anaerobic ammonium oxidation in paddy soil

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Nitrogen (N) is the most important yield-limiting nutrient for rice production. Flooding of rice paddies for an extended period of time creates anoxic conditions in soil which can favour a simultaneous occurrence of several microbial N transformation processes, such as dissimilatory nitrate (NO3-) reduction to ammonium (NH4+) (DNRA), denitrification and anaerobic NH4+ oxidation (anammox). Little is known about the role of DNRA and anammox in N cycling in paddy soils, and of the simultaneous occurrence of these N transformations. This study utilized a 15N isotopic approach to determine the rates of DNRA, denitrification and anammox processes simultaneously in a paddy soil. The paddy soil was collected from the Riverina region in New South Wales, Australia and studied under laboratory conditions. The rates of the processes were investigated after a week of flooding of paddy soil with basal N application at the rate of 1.6 g N m-2 (farmers practice in the region). Results showed that DNRA contributed to the formation of 0.005 mg NH4+-N hr-1 kg-1 soil, whereas denitrification and anammox accounted for the loss of 0.093 mg and 0.017 mg N2-N hr-1 kg-1 soil, respectively. Denitrification was the major pathway contributing to N2 production which accounted for 83% of total N2 produced. Anammox contributed to 17% of total N2 production. Considering the bulk density of soil (1.3 g cm-3), it can be estimated that DNRA can retain 0.03 g N m-2 day-1, whereas denitrification and anammox can contribute to a loss of 0.58 and 0.11 g N m-2 day-1, respectively, after the first week of flooding of paddy soil.