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Fixation and Release of Ammonium in Paddy Soils after Flooding

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Abstract

Poor utilization of N fertilizers by rice plants seems to be largely due to N losses from the soil plant system and through denitrification, leaching, runoff and NH_3 volatilization. Therefore, the primary aim of improved N management is to minimize transformation processes that result in N losses and to maximize N uptake. One important transformation process, which leads to a temporary immobilization of fertilizer N as well as of NH_4^+ from the deamination of organic N compounds, is the fixation of NH_4^+ ions by 2:1 clay minerals. However, factors which may have an impact on fixation and release of ammonium in paddy soils are still poorly understood. It is assumed that NH_4^+ fixation might be promoted by the decreasing redox potential in flooded soils, because of the reduction of structural Fe III, causing an increase of the negative charge of certain clay minerals. However, since rice plants are able to secrete O_2 into the rhizosphere, which may oxidize Fe II to Fe III, it seems possible that the release of fixed NH_4^+ might be promoted by rising the redox potential in the vicinity of the roots.

A series of model experiments were conducted to establish the effect of O_2 secretion from imitated rice roots on the availability of non-exchangeable NH_4^+ and N uptake by imitated rice roots under flooding conditions. The soil was flooded and incubated at 30°C. A special apparatus was used to imitate O_2 secretion and N uptake by rice roots. A PVC pipe sealed with a nylon net at one end was inserted into the soil. One week after flooding air was pumped into the PVC pipe by a gas dispenser to imitate O_2 secretion from rice roots. To simulate N uptake a nylon net bag filled with an ion exchange resin mixture was placed in the PCV pipe. Results on the influence of the redox potential on the fixation and release of NH_4^+ and N uptake will be discussed.

Keywords: N-utilisation, redox potential, rice

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