

Report for 2001KY2801B: Does waste amendment affect abiotic N cycling in soils by naturally occurring reactive Fe(II)?

- Conference Proceedings:
 - Matocha, Christopher, Gerald Haszler, Mark Coyne, and Ravi Kukkadapu, 2001, Abiotic Nitrogen Cycling in Kentucky, In 93rd Annual Meetings of Soil Science Society of America, American Society of Agronomy, Charlotte, NC.
 - Matocha, Christopher, and Gerald Haszler, 2001, Characteristics of Reactive Ferrous Iron, In 93rd Annual Meetings of Soil Science Society of America, American Society of Agronomy, Charlotte, NC.

Report Follows:

Problem and Research Objectives

Nitrate loss from soil is typically attributed to leaching or biological denitrification as default pathways. Field conditions at the surface and subsoil conducive for biological denitrification are also environments where other potential reductants are known to accumulate such as ferrous (Fe(II)) iron. An alternative abiotic pathway of NO_3^- reduction could involve oxidation of Fe(II) species, but the mechanisms are complex because of the heterogeneous nature of soil and multiple oxidation state changes of nitrogen that lead to either its conservation or loss. However, this reaction could play a significant role in coupling the redox cycles of N and Fe in soil environments, yet there is very little information available in this regard. The objectives were modified from the original proposal in that we wanted to first establish whether abiotic nitrate reduction was occurring prior to studying the effect of animal waste amendment.

Methodology

The stirred-batch kinetic experiments and field soil characterizations had to be conducted in an anaerobic chamber due to the sensitivity of solid Fe(II) minerals and adsorbed Fe(II) species. Therefore, the number of reference minerals and soils employed during the reactivity studies was reduced.

Principal Findings and Significance

The initial screening of minerals representative of Kentucky soils revealed that Fe(II)-bearing phyllosilicates showed very little reactivity towards NO_3^- due to repulsion effects. Dissolved Fe(II) alone reduced NO_3^- slowly, but when catalyzed with dissolved Cu^{2+} to simulate manure addition, NO_3^- was reduced to N_2O and ammonium (NH_4^+) in a complex, multistep reaction mechanism. Current experiments are evaluating the role of adsorbed Fe(II) as a possible reductant of nitrate. A method has been calibrated to determine the native Fe speciation on field soil samples. Solid phase Fe(II) and Fe(III) were distinguished only by quick freezing samples in the field immediately during sampling with liquid N_2 in a Dewar. All sample manipulation was conducted in an anaerobic glovebox or else Fe(II) concentrations decreased markedly. It is noteworthy that there was an inverse correlation between solid Fe(II) concentrations determined using this procedure and exchangeable NO_3^- concentrations, with a concomitant increase in exchangeable NH_4^+ . It is not known how reactive the extractable Fe(II) in the surface and subsurface is with respect to NO_3^- removal and ongoing studies are investigating this system.