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Nitrogen Turnover Rates at Low Temperatures in an Agricultural Peat Soil

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Nitrogen (N) cycling in agricultural soils has a key impact on the environment. Agricultural ecosystems are the most important sources of nitrous oxide, an important greenhouse gas, to the atmosphere. Additionally N fertilizers used to improve plant growth lead to enhanced N leaching and thereby to eutrophication of surrounding aquatic ecosystems. Microbial processes are normally enhanced by increase in temperature. Several recent studies have shown that although nitrous emissions from agricultural soils are of microbiological origin, produced mainly in microbial reduction of nitrate via nitric oxide and nitrous oxide to molecular nitrogen (denitrification), the temperature response of nitrous oxide emissions is greatly variable and there is a lot of evidence of high emissions during cold periods (e.g. Koponen et al. 2006). Denitrification is, however, regulated by availability of inorganic N and therefore dependant not only on N fertilization but also on N turnover processes in soil. These processes include mineralization of organic N to ammonium, oxidation of ammonium to nitrite and nitrate (nitrification). Regulation of these processses especially in low temperatures is poorly understood. In this experiment, gross rates of N mineralization and nitrification and carbon dioxide production were studied in various temperatures ranging from -1.5 to 15 °C.

Soil samples were taken from grassland on peat soil in Southern Finland (60o49'N, 23o30'E) on September 8th 2008 from depths of 0-10 cm. Temperature responses of N gross mineralization and nitrification and of microbial respiration were measured in a laboratory experiment. The incubation temperatures used for experiments were 15, 5, 2.5, 1.5, 0.5, 0, -0.5 and -1.5 ºC. After 7 d temperature-specific incubation, gross rates of N mineralization and nitrification were determined with pool dilution technique in a 24 h incubation experiment. This study showed that N turnover processes in agricultural peat soil exhibit temperature anomalies. Carbon dioxide production decreased linearly with decrease in temperature, while gross nitrification and mineralization rates showed high variability in low temperatures with no significant differences between studied temperatures.

References:

Koponen HT , Duran CE, Maljanen M, Hytönen J, Martikainen PJ. 2006. Temperature responses of NO and N2O emissions from boreal organic soil. Soil Biology Biogeochemistry 38, 1779-1787.