Key Factors, Soil N Processes, and Nitrite Accumulation Affecting Nitrous Oxide Emissions

Although there are many studies on how environmental conditions and agricultural practices affect nitrous oxide (N₂O) emissions, it is not well understood how N transformation processes are involved in mitigation strategies.

In the November–December 2016 issue of the Soil Science Society of America Journal, researchers conducted a series of laboratory incubation experiments and examined the effects of N (urea) application rate, soil water content, temperature, biochar incorporation, urease inhibitor (Agrotain Ultra), and nitrification inhibitor (N-Serve 24) on N₂O emissions and N transformation dynamics in a sandy loam soil.

In addition to N application rate, soil water content is a profound factor impacting N₂O emissions. Much higher emissions were found in soil above water-holding capacity (WHC) than those below. They also revealed that the linear correlation between soil nitrite (NO₂⁻) concentration and N₂O emissions was significantly different between two distinct ranges (above vs. below WHC). Biochar and the inhibitors all reduced total N₂O emissions >70%. However, all data on N transformation and pH support that the treatment (except the high water content) effects on N₂O emissions are mostly limited to a couple of weeks, indicating the challenges in mitigation.


Soil Air Permeability Facilitates Hydraulic Permeability Prediction

Reliable prediction of soil hydraulic characteristics is often required to assess soil and ground water contamination risk or soil remediation activities. Soil permeability to water either in saturated or unsaturated zones is one of the most important hydraulic characteristics. Direct measurement of soil permeability to water or hydraulic conductivity is the most reliable approach to characterize it. However, its direct measurement, either in the laboratory or the field, is time consuming and requires significant human intervention. Therefore, soil scientists have attempted to develop several indirect approaches to predict soil permeability to water using its readily available properties. Soil air permeability is one of the its most appropriate readily available properties in this regard.

In the November–December 2016 issue of the Soil Science Society of America Journal, researchers introduce a semi-theoretical equation to predict soil water permeability to water in an unsaturated zone using its air permeability as a predictor.

First, the researchers modeled soil air permeability by considering a similar phenomenon between water and air flows in soil medium. Then, they theoretically linked soil air permeability to its unsaturated hydraulic conductivity. Finally, they tested the proposed model using laboratory-measured data to check its accuracy. The accuracy check showed that the proposed model can predict unsaturated hydraulic conductivity of soil with an average evaluation error of 4%, illustrating reasonably high accuracy for the model.

Regarding the fast and nondestructive measurement of soil air permeability compared with its unsaturated hydraulic conductivity, the proposed model seems to be more practical to characterize unsaturated soil hydraulic conductivity and can improve the accuracy and efficiency of unsaturated soil hydraulic conductivity estimation.


Incubation experiment setup.

Source: Wikimedia/HolgerK.