Tightening Nitrogen and Carbon Cycling Using Clays

Nitrogen (N) and carbon (C) dynamics in agricultural settings are central to the global issues of food production and environmental pollution. Low-impact technologies are being sought to limit the gaseous release of these elements, which contribute to climate change and poor nutrient-use efficiency. Most technologies trialed to date have involved the application of chemical inhibitors to retard N mineralization processes. While some of these approaches have been effective in certain contexts, there is concern regarding the environmental persistence of these chemicals and their effects on agricultural ecosystems as well as human health.

In the March–April 2016 issue of the Journal of Environmental Quality, researchers report on a process-based investigation into the potential for clays to decrease gaseous N and C losses from soil-applied organic fertilizers. The team found that the clays could decrease ammonia (NH₃) emissions by 2× and nitrous oxide (N₂O) emissions by 3× and improve C retention by up to 10× compared with untreated fertilizer applications. This novel approach presents a promising opportunity to develop a technology to improve nutrient cycling in agricultural settings, particularly given that clays are ubiquitously distributed and environmentally benign. The team is testing the technology at the field scale.


Denitrifying bioreactors are organic carbon-filled excavations designed to enhance the natural process of denitrification for the simple, passive treatment of nitrate nitrogen. Research on and installation of these bioreactors has accelerated within the past 10 years, particularly in watersheds concerned about high nonpoint-source nitrate loads and also for tertiary wastewater treatment.

A special section in the May–June 2016 issue of the Journal of Environmental Quality aims to firmly establish that denitrifying bioreactors for treatment of nitrate in drainage waters, groundwater, and some wastewaters have moved beyond the proof of concept. This collection of 14 papers expands the peer-reviewed literature of denitrifying bioreactors into new locations, applications, and environmental conditions. There is momentum behind the pairing of wood-based bioreactors with other media (biochar, corn cobs) and in novel designs (e.g., use within treatment trains or use of baffles) to broaden applicability into new kinds of waters and pollutants and to improve performance under challenging field conditions such as cool early season agricultural drainage. Concerns about negative bioreactor by-products (nitrous oxide and hydrogen sulfide emissions, start-up nutrient flushing) are ongoing, but this translates into a significant research opportunity to develop more advanced designs and to fine tune management strategies. Future research must think more broadly to address bioreactor impacts on holistic watershed health and greenhouse gas balances and to facilitate collaborations that allow investigation of mechanisms within the bioreactor “black box.”

The special section should be online by mid-May at http://bit.ly/1TLFykv. Until then, view articles from this special section on the “Just Published” pages at http://bit.ly/1U5yldx.

Published online May 2, 2016

Nitrogen and carbon cycling improvements achieved through clay additions to organic fertilizer applications to soil. Data are upper and lower standard errors about the mean.