With declining student enrollment, funding, and discipline identity, what does the future hold for the agronomic, crop, and soil sciences?

Land Grant Challenge

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Simeters and drainage lysimeters underneath agricultural production fields to collect nitrate moving below the active root zone. However, soil coring and suction cup lysimeters only provide a “snapshot” of nitrate leaching. Therefore they are not very suitable to calculate total nitrate loading rates unless they are combined with computer models to calculate overall water movement. On the other hand, drainage lysimeters capture the entire leachate volume and nitrate concentration, which can then be used to calculate nitrate load passing below a specific soil depth. An additional advantage of this method is that it sums up overall nitrate leaching (both in space and time), which is a more realistic way of assessing total nitrate loads compared with other approaches. However, drainage lysimeters may not be suitable for fine-textured or structured soils, and the installation can result in appreciable soil disturbance.

In a recent study published in the July–August 2007 *Journal of Environmental Quality*, researchers evaluated these three different methods of nitrate leaching in mulched drip-irrigated and fertigated systems cultivated with vegetable crops in a sandy soil. Independent of the irrigation or nitrogen rate, nitrate leaching values measured from the ceramic cup lysimeters were lower than the values from the drainage lysimeter and soil-coring methods. However, overall nitrate concentration patterns were similar for all methods when the nitrate concentration and leached volume were relatively low.

The authors say that although each method of measuring nitrate leaching may have certain limitations, they enhance our understanding of the processes that control and/or can reduce nonpoint source pollution associated with agricultural production systems.


Atmospheric carbon dioxide (CO$_2$) is the dominant greenhouse gas contributing to global warming and climate change. Temperate conifer ecosystems represent regionally important stores of soil organic carbon that may act as a sink or source of CO$_2$ with changes in climate and plant litter input. Addition of plant litter to soil generally increases the rate and amount of soil carbon mineralization. This interaction is termed the *priming effect*. Despite the potential impacts of priming on soil carbon dynamics, few soil carbon models incorporate it or extensively characterize the impact of soil minerals on soil carbon dynamics.

Scientists at the University of Arizona and the University of California–Davis recently investigated the effects of conifer litter addition and soil minerals on the priming of temperate forest soil organic carbon. The study was funded in part by a cooperative agreement with the USDA and by the UC Davis Jastro and Shields Scholarship program. Results from the study are published in the July–August 2007 issue of the *Soil Science Society of America Journal*.

Isotopically labeled ($^{13}$C) conifer litter was added to a range of forest soils formed on various parent materials. The various parent materials provided soils with a broad spectrum of soil mineral assemblages. Soil and litter carbon mineralization, measured as CO$_2$ emissions from soil samples amended with conifer litter, were monitored over the course of a three-month laboratory incubation. The relative source of CO$_2$ (i.e., soil or litter) was determined according to the $^{13}$C isotopic signature of the respired CO$_2$. The ability to account for soil and litter C source utilization allowed for quantification of priming effects.

This conifer forest dominated by white fir (*Abies concolor*) on basalt parent material illustrates the typical canopy coverage and tree density within temperate conifer ecosystems of the Sierra Nevada, California.
as well as total carbon mineralization from each soil.

The study revealed that organic carbon mineralization and priming varied substantially by parent material and its influence on the soil mineral assemblage. In particular, soils with a greater proportion of amorphous iron oxides and organic-metal complexes exhibited significantly reduced total carbon mineralization. Soils enriched in these minerals also demonstrated decreased priming effects, most likely related to mineral-moderated soil carbon recalcitrance or adsorption of microbial exoenzymes. The majority of priming effects were short lived and resulted from stimulation of microbial growth, increased biomass, or exoenzyme production facilitated by the addition of the labile, energy-rich litter.

"An understanding of how parent material and soil minerals impact soil organic carbon cycling is important to modeling temperate conifer ecosystem response to climate change," says Craig Rasmussen, lead author of the study. "The results from this research clearly demonstrate that soil minerals affect the recalcitrance of soil carbon and the ability of the microbial community to access specific pools of carbon."

Research into soil mineral control over temperate forest soil organic carbon dynamics is ongoing at the University of Arizona. A National Science Foundation (NSF) sponsored project is currently investigating the role of organic-metal complexes in moderating soil carbon stabilization and microbial dynamics across a range of ponderosa pine ecosystems in Arizona. Identification of the specific physiological and environmental constraints on microbial activity affecting soil carbon mineralization will benefit climate change modeling efforts.