AGR1505: Has Transition to No-Tillage Resulted in More Free-Living Soil N Fixation?

The idea for this study arose from reports from a number of past nitrogen (N) balance studies conducted in Saskatchewan and Alberta. These studies consider all N inputs (fertilizer, crop residues, etc) and outputs (grain removal, soil erosion, etc) and calculated whether the soil has a net gain or a net loss of N. In all of these studies, a net loss of N from the system was predicted. However, when N was measured directly in the topsoil, a gain in N in the system was found. The gains were proportionate to cropping frequency – higher gains were found in continuously cropped systems, which generally are no-till, direct-seeded systems. One input that is not considered in the N balance studies is N fixed by free-living microorganisms. Unlike symbiotic N fixation that occurs in legume nodules, free-living microorganisms do not need a plant to fix N. This study measured free-living N fixation and the microorganisms responsible, in soils that have been under no-tillage management for varying amounts of time. Native prairie sites – the ultimate in no-till soils – were included. We also measured how the environmental conditions affect N fixation from year to year. In contrast to what we expected, the amount of time in no-tillage management did not affect the amount of free-living N fixation, and rates of N fixation were very low, ranging from 0.9 to 2.9 kg N ha^{-1} y^{-1}. Only after 50 years of no-tillage management did we see an indication that these soils supported higher N fixation rates. Indeed, the highest N fixation rate measured in an agricultural field was measured in an annually tilled organic field not in a no-tillage field. Rates of N fixation varied from year to year and in soils with different textures, but were overall very low. The community of organisms responsible for N fixation was very diverse. Soils immediately adjacent to one another but under different management had different communities of organisms. The diversity of microorganisms capable of fixing N means that the soils are capable of responding to environmental fluxes. An experiment looking at the microbial communities in soils repeatedly wetted and dried found that different organisms dominated under different soil moisture conditions. No single organism was adapted to the different moisture conditions, but the whole community together sustained N fixation over the wide range of moistures. While these small sustained levels of N fixation are undoubtedly important in natural ecosystems, they should have no impact on fertility decisions made by farmers.