Limited Impact of One-Time Dairy Manure Applications on Soil Microbial Communities in Corn-Alfalfa Rotations

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Animal manure has been used as a valuable soil amendment in agroecosystems to dispose of waste, recycle nutrients, and promote more sustainable agroecosystems. Manure applications can meet some or all of the nutrient requirements for optimal crop growth while also providing numerous soil health benefits, many of which are mediated via their impacts on soil microbial communities. Recently, single, high-rate applications of manure have been hypothesized to 'prime' soil systems by stimulating organic matter mineralization and nutrient cycling processes, thus having long-lasting impacts on nutrient provisioning to subsequent crops. This 'priming' effect of large manure applications suggests that lasting soil health benefits may offset transportation costs of hauling manure. However, it remains unclear how single, high-rate applications of manure drive soil microbial dynamics across space and time. The goal of this work is to determine how high and standard rates of dairy manure amendments modify soil microbial communities in corn-alfalfa forage cropping systems across distinct locations that vary in climate and soil characteristics. Specifically, we hypothesize that one-time, high-rate applications of dairy manure will drive persistent shifts in soil microbial communities, increase microbial diversity, and promote putative plant-beneficial microbial taxa. Using high-throughput sequencing of taxonomic markers (16S and ITS rRNA genes) we evaluated how soil bacterial and fungal communities responded to one-time standard and high doses of dairy manure versus synthetic or no fertilizer at different cropping phases of an alfalfa-corn rotation across two years at three locations in Minnesota. We found that spatial and temporal factors were the strongest drivers of soil community composition and diversity, followed by cropping phase. In contrast to expectations, fertility treatments had relatively small impacts on soil communities, suggesting that the impacts of liquid dairy manure on soil communities at the doses used here are minor or short lived. Together, these results suggest that priming soil communities for lasting benefits may require greater quantities or alternate forms of manure inputs.