Introduction

The goal of sustainable agriculture is to provide sufficient crop production through the conservative use of renewable resources while supporting ecological stability1. In recent decades, agricultural N use has received scrutiny for contributing to the disruption of the soil N cycle, excessive nutrient loss, and environmental degradation2. While the green revolution initiated commercial mineral fertilizer production, agriculture has since relied on increasing fertilizer rates to boost production to yield enough crops to feed humans, livestock, and supply inputs for biofuel production3,4. The intensive use of soluble mineral fertilizers is associated with high levels of nutrient loss, contributing to degraded water quality, as exhibited by the hypoxic zone in the Gulf of Mexico 5,6. While fertilization is essential for efficient crop production, fertilization based on soluble mineral N is prone to losses through leaching, limiting the sustainability of mineral-based agriculture 7. ~~Further, one of the most common fertilizers in the “corn belt” is anhydrous ammonia, which is associated with significant methane emissions during production 8.~~

A potential solution to address these concerns is to offset mineral N fertilizer use with organic N fertilizers, which are less prone to leaching and contribute to improvements in soil quality and sustainability 9. Generally, in organic agriculture, compost and green manures are used to supply N to the soil [cite]. Several investigations into organic N use in agricultural production systems have shown evidence that supports the role of organic N in sustainable systems. Cambardella et al. found A comparison of water quality between organic and conventional maize production showed significant differences in cumulative nitrate losses to drainage water, finding two times as much nitrate-N loss over three years in conventional plots compared to organic plots10. Conventional plots in commercial apple orchards leach more than five times the annual nitrate than organic plots, further evidence for reduced N leaching under organic management 11.

Despite evidence for the benefits of organic N fertilizer use, several factors contribute to the limited use of organic N fertilizers. One challenge is our lack of understanding of the synchrony between N released from amendment and plant uptake. When the timing of mineralization is asynchronous to crop needs, significant losses of N may occur. Therefore, for efficient crop production, application of organic nitrogen amendments must be carefully timed with consideration of factors contributing to mineralization, including stoichiometry of the amendment, , soil physical and chemical properties as well as environmental factors such as temperature and moisture. These factors each contribute in different ways to the overall timing of decomposition and depolymerization of organic N from amendments. IN particular, the microbial community profile…this community can directly influence mineralization rates

N mineralized from biological compounds into plant-available forms, and crop uptake is mediated in part by the bacterial community. Nitrogen from organic amendments is bound in large complex molecules such as proteins or amino acids and must be depolymerized into smaller and lighter bio-available forms before mineralization can proceed. Generally, complex interactions between soil bacteria and organic N composition of amendments challenge the predictability of nitrogen mineralization and nutrient availability in these agricultural systems. Further, there is significant phylogenetic diversity associated with extracellular enzyme production, contributing to the variations in mineralization between environments. Therefore, investigations into the unique bacteria responding to amendments intended to supply organic N are needed ~~to inform our understanding~~ of the bacterial communities present during depolymerization and mineralization, to contribute to our understanding and result in engineering more efficient organic N use. (link following better)Moreover~~, to facilitate the use of legumes and composts as sustainable nitrogen sources, research into the bacterial species stimulated in soils during decomposition of these amendments is needed.~~ Identification of unique bacterial groups responding to amendments using next generation 16s rRNA sequencing conjunction with soil chemical property analysis will inform our ability to predict and potentially manipulate these communities for improved efficiency and increased use of biological nitrogen sources.

In this study, we characterizes soil-bacterial dynamics in soils from organic grain systems in response to amendments commonly used for organic grain production. Organic management practices depend on N fertilization with composts and green manures. We expect there to be a shift in microbial community composition and structure in soils following amendment and that this response will vary significantly depending on the ratio of carbon to nitrogen in the amendment. As compounds decompose and nutrient availability changes, we expect that predictable groups of microbes characterize the shifts in community composition. The results of this study will improve our understanding of the biological players involved in the release of nutrients, helping to improve agricultural production while maximizing environmental benefits from organic nitrogen amendments.

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Despite evidence for the benefits of organic N fertilizer use, several factors contribute to the limited use of organic N fertilizers. One challenge is our lack of understanding of the synchrony between N released from amendment and plant uptake. When the timing of mineralization asynchronous to crop needs, significant losses of N may occur. Therefore, for efficient crop production, application of organic nitrogen amendments must be carefully timed with consideration of factors contributing to mineralization, including stoichiometry of the amendment, microbial community profile, soil physical and chemical properties as well as environmental factors such as temperature and moisture. These factors each contribute in different ways to the overall timing of decomposition and depolymerization of organic N from amendments.

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In this study, we characterize soil-bacterial dynamics in soils from organic grain systems in response to amendments commonly used for organic grain production. Organic management practices depend on N fertilization with composts and green manures and microbially mediated N release. Less than 1% of the soil bacterial community can be cultured in the lab; our methods expand identification of bacteria responding to amendment with culture independent techniques. We expect there to be a shift in microbial community composition and structure in soils following amendment and that this response will vary significantly depending on the ratio of carbon to nitrogen in the amendment. As compounds decompose and nutrient availability changes, we expect that predictable groups of microbes characterize the shifts in community composition. The results of this study improve our understanding of the biological players involved in the release of nutrients, helping to improve agricultural production while still maximizing environmental benefits from organic nitrogen amendments.