INTRODUCTION

PARAGRAPH 1

Practicing agriculture in a way that benefits the environment while supporting the human population requires efficient use of both biological and synthetic nitrogen. (Tilman et al. 2002)⁠

Abundant atmospheric N is incorporated into tissues of legumes via symbiotic relationships with rhizobia, this biologically fixed nitrogen offers a sustainable source of fertility to growers.

Legumes such as alfalfa or clover are grown in the year or two prior to maize, releasing nitrogen when incorporated and decomposed in the soil.

Efficient use of this source of nitrogen is possible when soil microbes successfully mineralize it to meet crop fertility needs.

Complex interactions between soil biota and organic nitrogen challenge the predictability of mineralization in these systems, limiting efficiency and therefore use of legumes as biological nitrogen sources.

To facilitate the use of legumes as sustainable nitrogen sources, research into the bacterial species stimulated in soils during decomposition is needed.

Identification of unique bacterial groups responding to amendments will inform our ability to predict and potentially manipulate them for improved efficiency and use of biological nitrogen sources.

PARAGRAPH 2

N-bearing polymers must be depolymerized into smaller and lighter forms that can be assimilated by microbes before mineralization of nitrogen can occur.

Depolymerization is a function of enzyme production by a range microbial species, the response of which is influenced by the microbial composition and nutrient availability of the soil and amendment.

Augmentation and stimulation of species, particularly those controlling decomposition and nutrient cycling, are potential approaches for improving nutrient use efficiency.

There is a knowledge gap associated with identification of bacterial response to amendments in alfalfa soils from agroecosystems, specifically the response unique to amendment.

Identification of bacteria responding during decomposition of amendments and mixtures of amendments will inform our understanding of biologically mediated nutrient cycling.

Particularly beneficial is the characterization of the bacterial community at multiple time points during a decomposition event, capturing the temporal dynamics.

Additionally, efforts to describe bacteria responding during decomposition will facilitate the generation of target species for bio augmentation and stimulation.

PARAGRAPH 3

Balancing the rate of depolymerization and mineralization of nitrogen from soil organic matter to closely match the needs of the growing plant will provide a more efficient supply of nutrients to plants while minimizing losses to the environment.

This biologically mediated process has been associated with litter/amendment C: N ratios below 25:1.

When C: N ratios of more than 25:1 are observed in litters and amendments, immobilization has been observed, which is the utilization of nitrogen compounds for microbial growth at the expense of plant available mineral nitrogen. Thus C: N ratios are a critical factor affecting the impact of organic fertilizers on levels of plant available nitrogen in the soil.

Sustainable and regenerative agricultural management is focused on improving soil as a critical component of economic crop production. through a wide range of approaches, one of which is the use of high nitrogen leguminous residues and roots from crops in an extended rotation. This approach utilizes the natural ability of rhizobacteria to fix atmospheric nitrogen in the tissues of legumes, which then can act as nitrogen fertilizer when residues and roots are incorporated into the soil.

The availability of this nitrogen for plant growth is predominately dependent on the soil microbial biomass and it’s cycling of nutrients, particularly nitrogen mineralization, from organic matter. Several studies have demonstrated the diverse and unique bacterial response to amendments, which is driven by the nutrient profile and structural complexity of the residue that is added or incorporated.

Decomposition of nitrogen containing plant residues and composts is a crucial source of nitrogen in agroecosystems, particularly under organic management. Inherent variability in decomposition rates across soils and ecosystems presents challenges for predicting nutrient supply for crops from these amendments. One factor contributing to this variability is the composition and structure of the microbial community of the soil, particularly bacterial species, understanding the role community structure plays is central in developing our understanding of the biological aspects of decomposition.

Agricultural output of crops with high nutrient demand (e.g., maize) requires soils to be amended with nitrogen fertilizers for economical production. Plants require mineral nitrogen for growth, and cycling nitrogen between organic and mineral forms is a crucial process to understand for efficient agricultural management. Following the green revolution and development of synthetic mineral fertilizers, agricultural output has increased significantly to feed the growth of the human population. This increase in production is paralleled by increased mineral fertilizer usage and agricultural output, with environmental side effects. Not only does the production of these fertilizers contribute to increases in atmospheric greenhouse gases, but soluble mineral fertilizers can leach into our waterways and cause eutrophication and degraded water quality.

Soils under crop production in agricultural ecosystems are currently a significant source of nitrogen pollution in surface and groundwaters, largely due to the use of synthetic fertilizers.

Nitrogen fertilization with organic amendments is an alternative to synthetic fertilizers with a wide range of potential soil health benefits from the additional organic matter. In organic amendments, nitrogen is provided to soils from plant litter, microbial cells, and animal wastes. Compared to synthetic fertilizer, little is known about the soil nitrogen cycle from organic amendments. This is partly due to the variety of amendments…. We do know that amendments are good because…. However, the key to using these amendments to replace commercial fertilizers is a better understanding of how mineral and inorganic N is made available in the soil. Specifically, we need to identify the key microbial players that are involved in nitrogen cycling.

Previous research has revealed that organic matter in soils, particularly N-bearing compounds, must be depolymerized into smaller compounds that can be assimilated by microbes or acted upon by extracellular enzymes before assimilation. Depolymerization regulates N cycling and controls N entering the microbial pool where it can then be mineralized into plant available forms. Balancing the rate of depolymerization and mineralization of nitrogen from soil organic matter to closely match the needs of the growing plant will provide a more efficient supply of nutrients to plants while minimizing losses to the environment. This biologically mediated process has been associated with litter/amendment C: N ratios below 25:1. When C: N ratios of more than 25:1 are observed in litters and amendments, immobilization has been observed, which is the utilization of nitrogen compounds for microbial growth at the expense of plant available mineral nitrogen. Thus C: N ratios are a critical factor affecting the impact of organic fertilizers on levels of plant available nitrogen in the soil.

In this study, we aimed to understand specifically the soil microbial response to organic amendments. Improving our understanding of the biological players involved in nutrient release could help improve agricultural production while still maximizing environmental benefits from complex amendments. We hypothesize that distinct microbial communities respond to varying organic amendments. In this study, we study the impacts of amendments of both alfalfa and compost, provided at 3 equal rates of total nitrogen, to a soil but with differing C: N ratios ….let’s work on this paragraph together!.... immobilization (compost) or mineralization (alfalfa). We characterize both the chemical and microbial response to these amendments and hypothesize that specific microbial communities will respond to initial nitrogen and carbon availability and that this membership will be specific to varying amendments. We expect that these distinct early microbial responders will dominate soil microbial communities in response to organic amendments and will decrease in abundance through time. Our objective was to characterize these early responding microbial communities for various organic amendments and to identify potential microbial membership within organic amendments that may be involved in plant nutrient availability.