Introduction Paragraphs

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Agricultural output of crops with high nutrient demand (e.g., maize) requires soils to

be amended with nitrogen fertilizers for economical production 1 . Following the green

revolution and development of the ability to synthesize mineral fertilizers, agricultural output

has increased significantly to feed the growth of the human population 2 . This increase in

mineral fertilizer usage and agricultural output has had environmental side effects. Soluble

mineral fertilizers are prone to leaching and losses to water ways, where they contribute to

eutrophication and degraded water quality 3 . Additionally, fossil fuel use in the production of

fertilizers contributes to increases in atmospheric greenhouse gases 4 . To cope with the

demands of an increasing human population, agricultural production must become both

more sustainable and more efficient to minimize impacts on the environment.

An alternative method to provide nutrients for agriculture is fertilization of soils with

inputs approved for organic management. These organic managements techniques exclude

the use of synthetic mineral fertilizers and instead rely on addition of nitrogen via

amendments with compost, manure, or green (plant-based) manures. To use the nitrogen

from these amendments, crops rely on biological transformation nitrogen in organic forms

into plant available nitrogen. Currently, little is known about the microbial community

during these processes in organic agriculture, especially how to optimize the amounts of

nitrogen available to plants post amendment with organic fertilizers. Further, nutrient

availability varies by the type and nutrient ratios of organic fertilizers. For example, the

carbon to nitrogen ratio of organic amendments impacts the decomposition rate and whether

N is mineralized into plant available forms or immobilized by the soil microbial biomass 5,6 .

A better understanding of the microbial communities and their responses to nutrients2

available from organic amendments will help improve its effective adoption and usage.

Previously, the use of organic management has been observed to reduce nitrogen

losses to sub-surface waters. For example, in a study comparing an organic corn soybean

production system utilizing extended crop rotations and animal manures for nitrogen

fertilization, to a conventional corn-soybean system fertilized with synthetic urea, reduced

losses of nitrates were observed in the tile drainage water from the organic system compared

to the conventional system 7 . This is evidence to the potential of organic agriculture to

ameliorate environmental degradation associated with intensive chemical agriculture. Within

this study, reduced nutrient losses into the environment was associated with high variability

and reduction in yields, which may be linked to the ability of the soil microbiome to liberate

nitrogen bound in complex organic compounds, transforming it into mineral forms and

ultimately making it available for plant uptake and growth. This biologically mediated

process where plant available nitrogen is released from organic sources is known as

mineralization and 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 5 . Thus C: N ratios are a critical factor affecting

the impact of organic fertilizers on levels of plant available nitrogen in the soil.

Improving our understanding of the biological players involved in nutrient release

could help improve organic production while still leveraging its environmental benefits. A

key knowledge gap for varying organic management strategies is understanding the soil

nitrogen (N) pool and the role of associated microbial communities as drivers of N cycling.

In this study, we study the impacts of amendments of both alfalfa and compost, provided at3

equal rates of total nitrogen, to a soil but with differing C: N ratios chosen to result in

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.