Nutrient Availability and Food Safety of Organic Matter Amendments

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Interpretive Summary

Use of conventional fertilizers for nitrogen (N), phosphorus (P), and potassium (K) nutrition results in beneficial outcomes for agronomic performance but, also comes with important economic and environmental costs. We examined the effects of composted manure and green waste compost on nutrient availability, soil moisture, and human pathogen persistence under root exclusion. We found significantly greater soil moisture in the early part of the growing season for green waste compost compared to the control. There were no difference in the decomposition rate between composted manure and green waste compost of ~4.5 lbs dry mass acre^{-1} day^{-1}. There were no differences in the amount of total inorganic nitrogen (NH_4^+-N + NO_3^--N) adsorped to the surfaces of resin membranes in the top soil (0 – 10 cm) despite the added N input for the organic matter amendments. Greater inputs of P and K from organic matter amendments resulted in significantly greater adsorption of PO_4^{3-}-P and K^+ to surfaces of resin membranes compared the control. These results suggest that organic matter amendments play an important role in N immobilization that can increase soil N retention and contain readily available P and K that may be able to act as a substitute for other P and K fertilizers and lead to cost savings for the grower.

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Objectives

- To assess chemical characteristics of organic matter amendments
- To screen organic matter amendments for human pathogens
- To estimate decomposition from organic matter amendments
- To assess the effect of organic matter amendments on soil moisture
- To determine adsorption of nutrient ions during a growing season

Materials and Methods

We established a research trial in a non-bearing almond orchard near Escalon, CA. The study site is a Manteca fine sandy loam planted in 2014 with 18' tree and 22' row spacings of 'Nonpareil' interplanted with pollinators grafted on 'Hanson' rootstock. The experimental design is a randomized complete block design with four blocks and three treatments including composted dairy manure (Nunes Dairy Farm Escalon, CA), green waste compost (Recology San Francisco, CA), and a control. All plots received the same amount of water and supplemental fertilizer. Plots were maintained with *root exclusion* where tree roots were excluded for the duration of the experiment. Prior to application samples of the organic matter amendments were taken for chemical characterization (Table 1) and examined for the presence of the human pathogens using cultural methods.

Estimates of decomposition utilized litter bags where organic matter amendments were applied at the equivalent rate of *3 tons per acre* at 37% moisture on the tree berm. In order to assess the effect of organic matter amendments on soil moisture, soil was sampled (0 – 10 cm depth) every two weeks during the growing season. Each month PRS^{TM} probes (Western Ag Innovations Saskatoon, Canada) were deployed for one month where the surface of the resin membranes absorbed nutrients including NH_4^+, NO_3^-, PO_4^{3-}, and K^+.

Table 1. Chemical characteristics of composted manure (CM) and green waste compost (GWC) including pH, electroconductivity (EC), total organic carbon (TOC), total nitrogen (TN), carbon to nitrogen ratio (C:N), ammonium (NH_4^+-N), nitrate (NO_3^--N), Olsen orthophosphate (PO_4^{3-}-P), exchangeable potassium (K^+), calcium (Ca), magnesium (Mg), calcium to magnesium ratio (Ca:Mg), sodium (Na), chloride (Cl), and boron (B)

	pH	EC dS/m	TOC %	TN %	C:N
CM	7.93	29.1	28.3	2.35	12.1
GWC	4.69	22.5	34.8	1.87	18.6
	NH_4^+-N mg/kg	NO_3^--N mg/kg	PO_4^{3-}-P mg/kg	K^+ mg/kg	Ca mg/kg
CM	351	223	2655	26895	0.68
GWC	1250	6.8	271	7410	8.95
	Mg mg/kg	Ca:Mg mg/kg	Na mg/kg	Cl mg/kg	B mg/kg
CM	0.62	1.09	5.63	13.3	0.04
GWC	7.53	1.19	5.44	11.6	0.04

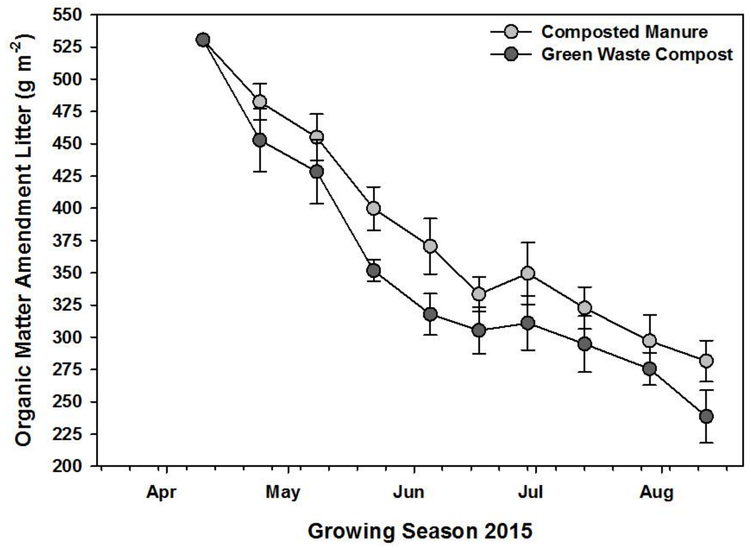

Figure 1. Changes in mass loss during 4-month incubation for different sources of organic matter amendments including composted manure and green waste compost placed on the tree berm under no-tillage. Values are means (n = 4) with standard error bars.

Results

Chemical Characteristics and Human Pathogen Presence

Chemical characterization of organic matter amendments showed differences in various parameters with marked differences in pH, TN, NH_4^+, NO_3^-, PO_4^{3-}, and K^+ (Table 1). All samples of composted manure and green waste compost were negative for all pathogens examined including *Salmonella enterica*, *Escherichia coli* O157:H7, and *Listeria monocytogenes*. We also performed coliform plate counts on all samples, none of which were over 2 log CFU gm^{-1}

Decomposition

Changes in mass loss from organic matter amendments were greater for green waste compost compared to composted manure; however these differences were not significant (Figure 1). After four months, 45% of the initial mass of the green waste compost remained compared to 53% of the composted manure. The average rate of mass loss was ~0.5 g m^{-2} day^{-1} *or* 4.5 lb dry mass acre^{-1} day^{-1} during the growing season.

Soil Moisture

Sampling of soil moisture was conducted biweekly at 1 or 2 days before scheduled irrigations in order to assess volumetric water content at drier periods of the wetting cycle. Differences were detected during late April and early May where green waste compost was significantly greater in volumetric water content compared to the control while there were no differences between green waste compost and composted manure as well as composted manure and the control (Figure 2).

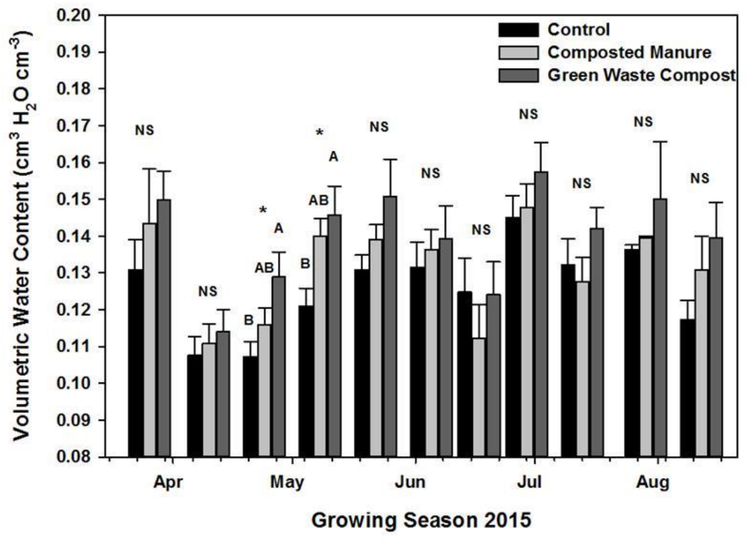

Figure 2. Volumetric water content from top soil (0 – 10 cm) mulched with organic matter amendments of composted manure or green waste compost compared a control. Values are means (n = 4) with standard errors. Differences are reported as significant (p < 0.05) with an asterisk (*) or as not significant (NS) using a Tukey test.

More Results

Nutrient Dynamics

Throughout the growing season total inorganic N (NH_4^+-N + NO_3^--N) adsorbed to resin membranes were not significantly different. During late April green waste compost was greater than composted manure and the control possibly due to higher NH_4^+ content that may have been more readily available in the top soil (0 – 10 cm). (Figure 3). Furthermore, the higher inputs of PO_4^{3-} and K^+ from the composted manure resulted in significantly greater adsorption to resin membranes compared to green waste compost and the control for nearly all sampling dates (Figure 3).

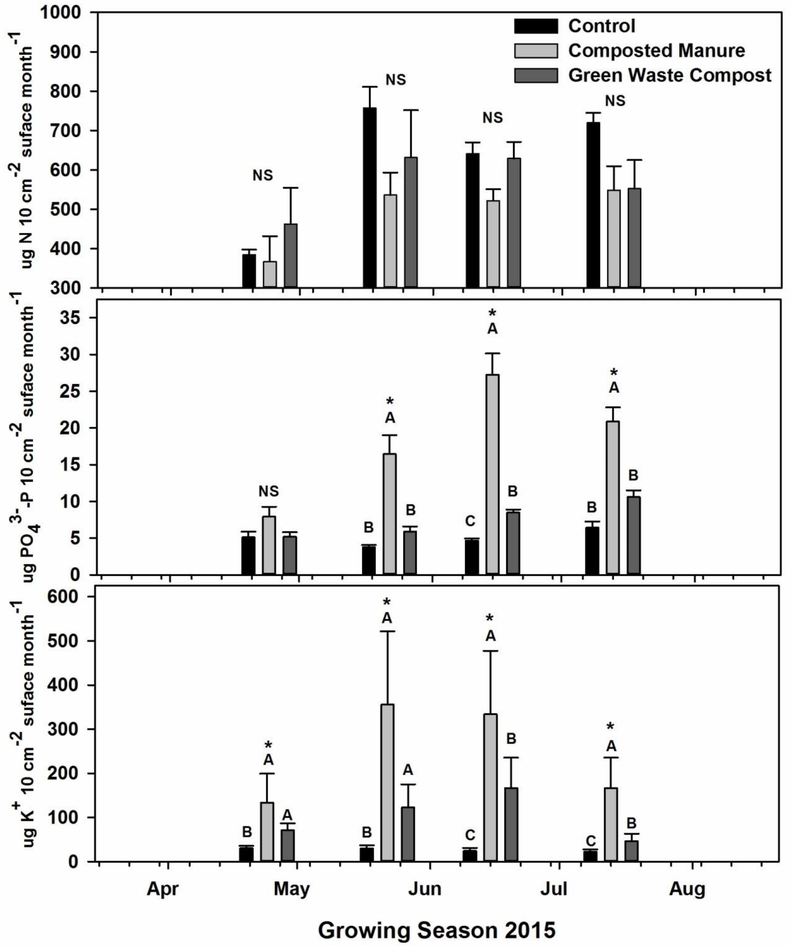

Figure 3. Total inorganic N (NH_4^+-N + NO_3^--N), phosphate (PO_4^{3-}-P), and potassium (K^+) per 10 cm^{-2} of resin membrane surface per month from top soil (0 – 10 cm) applied with organic matter amendments of composted manure or green waste compost compared to a control. Values are means (n = 4) with standard errors. Differences are reported as significant (p < 0.05) with an asterisk (*) or as not significant (NS) using a Tukey test.

Conclusions

Integrated nutrient management of organic matter amendments offers a viable option to supplement conventional fertilizers with other associated co-benefits. Composted manure and green waste compost differed in some chemical characteristics while both were pathogen free. We found significantly greater soil moisture in the early part of the growing. The decomposition rate was the same. There were no differences in the amount of total inorganic N adsorption and significantly greater adsorption of PO_4^{3-}-P and K^+. These results suggest that organic matter amendments play an important role in N immobilization that can retain N in the soil and may be able to act as a substitute for other P and K fertilizers.

Acknowledgements

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Reference

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