ESTIMATING NITROGEN CREDITS FROM ORGANIC MATTER SOURCES IN ORCHARDS

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ABSTRACT

Addressing N availability from organic matter sources in orchards, and in turn estimating appropriate N credits used in nutrient budgets remains a challenge. Soil health practices like cover crops and organic matter amendments add organic matter (OM) to soil in order to improve water holding capacity and maintain N in orchard top soil, thereby reducing the potential for nitrate leaching. Organic matter added to the soil contains N, however the rate at which that N becomes plant available varies dramatically depending upon on the organic matter source. We reviewed twelve extension publications across the U.S. and extracted 90 data points estimating N availability coefficients for total N inputs from different organic matter sources at one or two years after application. Year one coefficients varied for different organic matter sources including compost from -8 to 28%, beef or dairy manure solids from 16 to 40%, poultry manure solids from 24 to 52% and cover crops from 8% to 48% of total N inputs. Less data was available for year two coefficients including one data point for compost at 5%, beef or dairy from 8 to 24% and poultry from 8 to 16%. Additional parameters need to be considered when estimating N credits from organic matter sources in orchards including 1) application in tree row or alleyway; 2) application postharvest before winter rains or in springtime; 3) proportion of orchard soil wetted by irrigation water and; 4) no-till practices or use of incorporation to manage organic matter. Different N sources offer growers options to balance nutrition for orchard crops. In combination with the right rate, timing and placement, the right N sources optimize productivity and minimize N losses.

INTRODUCTION

In California, orchard crops like almond (*Prunus dulcis*) are planted on over 1.3 million acres and rely heavily on fertilizer and irrigation water for high productivity. Almonds can effectively utilize different N sources to meet the high annual N demand for fruit and tree growth. Different fertilizer formulations like urea ammonium nitrate are widely and effectively used, and readily available for uptake. Yet, addressing N availability from organic matter sources in orchards, and in turn estimating appropriate N credits used in nutrient budgets remains a challenge. Soil health practices like cover crops and organic matter amendments add organic matter (OM) to soil in order to improve water holding capacity and maintain N in orchard top soil. Organic matter added to the soil contains N, however the rate at which that N becomes plant available varies dramatically depending upon on the organic matter source. Furthermore, a greater understanding of how N availability changes from one year to the next is needed.

Additional factors may need to be considered when estimating N availability from organic matter sources in orchards. These include use in the tree row or alleyway; the proportion of orchard soil wetted by irrigation water, and use of no-till or tillage of OM. The aim of the following is 1) to outline the finding of N availability coefficients available in research and extension literature and 2) to provide recommendations for updating grower decision support tools such as the UC CropManage platform and the California Almond Sustainability Program N calculator.

METHODS

We reviewed twelve extension publications across multiple land grant institutions in the United States (See references below) and extracted 90 data points estimating N availability coefficients defined as the percent of N available as ammonium or nitrate out of total N inputs from organic matter sources at one and more than one year after application. Additional data parameters collected when available included percentage of dry matter, carbon-to-nitrogen ratio (C:N), total N (TN) and the proportion of ammonium (NH4) to TN. Notes were made for examples that included incorporation with tillage or management of organic matter sources as no-till mulch. Results are reported independent of management practices employed. The N availability coefficients reported herein are designed to be unitless values to be multiplied by the total N contents of each organic matter source in dry mass per unit area.

RESULTS AND DISCUSSION

Year one coefficients varied for different organic matter sources including compost from -8 to 28%, beef or dairy manure solids from 16 to 40%, poultry manure solids from 24 to 52% and cover crops from 8 to 48% of total N inputs (Figure 1). Less data was available for year two coefficients including one data point for compost of 5%, beef or dairy manure solids from 8 to 24% and poultry from 8 to 16% (Figure 2). Studies specific to orchards are lacking, however Khalsa et al. (*Submitted*) report a range of -6 to 8% from composted sources in an almond orchard depending on the initial C:N.

Nitrogen losses via ammonia volatilization from surface application of manure is a primary finding to consider for orchards. Multiple extension publications report 100% of ammonium loss from manure when surface applied with no-till. The proportion of ammonium out of total N ranged from 0.0 to 6.7% for compost, 5.6 to 55% for beef and dairy, and 17 to 67% for poultry. No-till use of compost in orchards does not appear to be a significant path of ammonia loss. However, if growers opt to use manure, a factor of days until incorporation should be included.

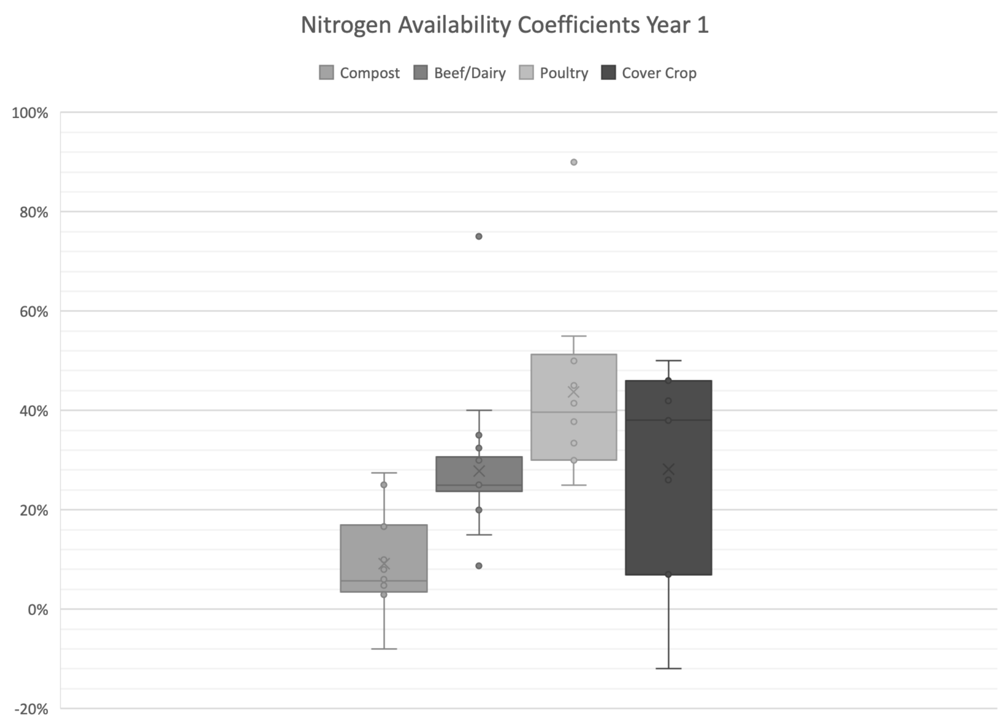

Figure 1. Box plots of nitrogen (N) availability coefficients defined as the percent of N available as ammonium or nitrate out of total N inputs for year one after application for organic matter sources including compost, beef and dairy, poultry and cover crops.

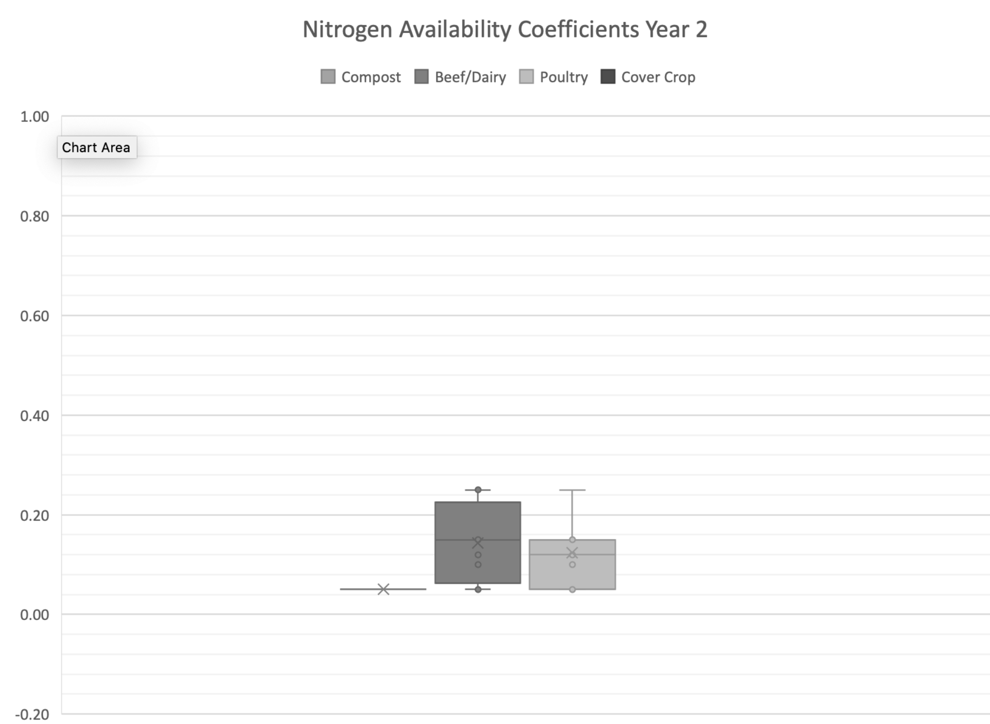

Figure 2. Box plots of nitrogen (N) availability coefficients defined as the percent of N available as ammonium or nitrate out of total N inputs for year two after application for organic matter sources including compost, beef and dairy, poultry and cover crop.

The current decision support tools in California like CropManage and the California Almond Sustainability Program N calculator require an update to accurately estimate N credits. The following are the most accurate quantification of N credits assuming all input parameters are available to the user of the decision support tool.

The following are examples that demonstrate parameters to collect for each organic matter source and ask the question, “What would be the N credit for the subsequent growing season?”:

Manure
Application rate in lbs/ac (AR)
Moisture in % (H2O)
Total N in % (TN)
Ammonium in % (NH4)
Tillage factor (tf)

1.00 = Incorporation 0 days after application
0.65 = Incorporation 1 day after application
0.50 = Incorporation 2 days after application
0.40 = Incorporation 3 days after application
0.30 = Incorporation 4 days after application
0.20 = Incorporation 5 days after application
0.20 = Incorporation 5 days after application
0.10 = Incorporation 6 days after application
0.00 = Incorporation 7 days after application

N Credit = AR * (1-H2O) * [([TN-NH4] * 0.25) + (NH4 * [tf])]
Example – In November, a grower applies 4 tons per acre of dairy manure at 30% moisture, 2.5% Nitrogen (0.5% ammonium) and incorporates the manure into the orchard alleyway 2 days after application.

8,000 lb/ac * (0.70 dry matter) * [([0.025 – 0.005] * (0.25)) + (0.005 * 0.50))] = 42 lb N/ac

Note – This approach may be used for all manure. The higher N coefficients reported above for poultry assume no losses from rapid incorporation. If the ammonium concentration and tillage factors are available, the same coefficient 0.25 may be considered for all manure sources.

Compost
Application rate in lbs/ac (AR)
Moisture in % (H2O)
Total N in % (TN)

N Credit = AR * (1-H2O) * (TN) * (0.10)

Example – In November, a grower applies 4 tons per acre of compost with a C:N between 11 to 13 at 30% moisture, 2.0% Nitrogen (0.0% ammonium) on the tree berm without tillage.

8,000 lb/ac * (0.70 dry matter) * (0.02) * (0.10) = 11 lb N/ac

Note – This example assumes compost C:N from 10 to 15, values higher than 15 may result in lower coefficients less than 0.10, equal to 0.0 or even negative leading to immobilization.

Cover crops
Biomass production in lbs/ac (AR)
Moisture in % (H2O)
Total N in % (TN)
Quality factor (CN)

0.50 = Cover crop with TN equal to 4.0%
0.46 = Cover crop with TN equal to 3.5%
0.42 = Cover crop with TN equal to 3.0%
0.38 = Cover crop with TN equal to 2.5%
0.26 = Cover crop with TN equal to 2.0%
- 0.12 = Cover crop with TN equal to 1.5%

N Credit = AR * (1-H2O) * (TN) * (CN)

Example – In March, a grower estimates a cereal rye cover crop stand of 6 tons per acre at 75% moisture, 2.0% Nitrogen.

12,000 lb/ac * (0.25 dry matter) * (0.02) * (0.26) = 16 lb N/ac

Note –A cover crop stand will depend greatly on winter rain fall. Furthermore, the quality factor for a cover crop will be affected by the developmental stage and termination date of the cover crop.

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