PNW 673

Sampling Dairy Manure and Compost for Nutrient Analysis

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Introduction

TESTING THE NUTRIENT CONTENT of a dairy manure or compost is a critical step in (1) understanding its nutrient value and (2) determining the application rate for crop production. Unfortunately, poor sampling practices and/or inappropriate lab techniques can compromise the quality of the sample, which can decrease the accuracy of the nutrient analysis. Using sampling, testing, and interpretation techniques described in this publication will help producers to have greater confidence in their nutrient analysis results and to better use the nutrients present in manures and composts.

This guide describes how to:

- Obtain a representative sample of stockpiled dairy manure or dairy compost
- Select a reliable manure or compost testing lab
- Determine which lab analyses are needed
- Estimate nutrient availability

Once the nutrient content of the manure or compost is known, a grower can make informed decisions about how to manage manure and fertilizer applications to meet the needs of a specific crop. Nutrient requirements of specific crops are detailed in fertilizer guides from University of Idaho Extension, Oregon State University Extension Service, and Washington State University Extension.

Sampling Guidelines

Manure composition can vary widely from one pile to the next due to cattle type, bedding type, dairy management practices, age of manure, manure stockpiling and composting practices, and other factors. This variability often discourages people from testing the manure for nutrient content due to concerns that the analysis will not be representative of the manure pile. This concern can be partially addressed by employing appropriate sampling techniques. While the resulting analysis may not reflect the exact average nutrient content of the manure pile, in most cases it will provide sufficient information for estimating nutrient application rates.

Sample timing

Sample the manure or compost as close to the time of application as possible. This timing is more critical for manure than compost because manure contains ammonium and volatile organic compounds that are in the process of being broken down by microbes. Compost material, in contrast, has already been through the active decomposition process and the remaining stable organic compounds are unlikely to change significantly over a period of weeks or even months. Therefore, we recommend that manure be tested within 1 to 2 weeks of application, while compost should be tested within 1 to 2 months of application.

Sample collection

The samples submitted to the lab should be a composite of multiple samples collected from the pile. Combining several samples reduces analysis quality issues associated with variability in the pile because

Contents

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the sample will be representative of the entire pile and not just one section of the pile. For detailed sampling instructions, see page 5.

Sample submission to testing lab

If possible, the manure or compost sample should be submitted immediately to a manure testing lab. Otherwise, the sample can be refrigerated up to 2 weeks without significant changes in the nutrient content of the sample. If shipping samples, make sure to ship overnight in a cooler with ice packs. If the sample gets too warm, microbes in the manure will convert organic nutrient forms to plant-available nutrient forms, thus altering the plant nutrient content and the overall quality of the sample. Consider contacting the lab receiving your sample in advance; most labs have specific protocols in place to ensure that sample quality is not compromised in transit. If possible, try to collect and send samples on a Monday or a Tuesday. Samples mailed on Thursdays or Fridays sit outside or at room temperature over the weekend. Finally, consider collecting two samples and keeping one as a back-up in the event the sample is lost or compromised or in case you have concerns with the quality of the analysis report.

Manure and Compost Testing Labs

Ideally, labs selected for manure or compost testing should be actively participating in a lab certification program for manure analysis. This step helps to ensure a reliable analysis of nutrient content and other parameters in the manure or compost sample.

Manure Analysis Proficiency Program (MAP)

The Manure Analysis Proficiency Program (MAP) is conducted by the Minnesota Department of Agriculture on a yearly basis to determine if manure-testing labs throughout North America can accurately measure total nitrogen (N) and total phosphorus (P) content in manures. Individual labs may also select to be tested and certified for additional elements. The MAP certification is appropriate for most Idaho growers who are working with manure or compost applications. Government-incentive programs like EQIP often require manure analyses to be conducted at MAP-certified labs. More information about the MAP program, along with the most current list of MAP-certified labs located throughout the U.S., is located at: http://www2.mda.state.mn.us/webapp/lis/manurelabs.jsp

Compost Analysis Proficiency Program (CAP)

In addition to the MAP certification program, labs may choose to participate in the Compost Analysis Proficiency Program (CAP) conducted by the U.S. Composting Council. The CAP certification process is more intensive than the MAP certification process, requiring proficiency testing for additional nutrients, seedling emergence and vigor, carbon dioxide evolution, particle size, fecal coliform, pathogen populations, and inert materials. More information about CAP-certified labs can be accessed at: http://compostingcouncil.org/labs/

Laboratory Analyses

Essential analyses

For all growers intending to field-apply manure and compost, the essential analyses are these:

- Total nitrogen (N)
- Nitrate-N (NO_3-N)
- Ammonium-N (NH_4-N)
- Total phosphorus (P)
- Total potassium (K)
- Solids (or moisture) content

Please note that these total nutrient content analyses *are not* the same as the nutrient analyses used for plant-available nutrients in the soil (like Olsen/Bray P, DTPA Zinc (Zn), etc.). Be sure to specify that your sample is a manure or a compost sample (and not a soil sample), and that you are requesting an analysis of total nutrients instead of plant-available nutrients. Typical ranges for total N, P, and K concentrations in dairy manures and composts in the Pacific Northwest region are listed in table 1.

Plants generally respond more readily to N, P, and K than other plant nutrients in manure; therefore we recommend that growers have at least these three key

Table 1. Typical nutrient and moisture contents of dairy manure and compost in eastern Oregon, eastern Washington, and Idaho.

Component	Typical range (lb/ton, as received)
Total N	10 to 30
P_2O_5	10 to 30
K_2O	20 to 80
% Moisture*	25 to 75

*Moisture contents of composts tend to be in the lower end of the range (25–35%), while moisture contents of manures are generally higher (60–70%).

nutrients analyzed from the manure sample. It is also important to know N and P concentrations in order to avoid excessive application rates that could contribute to nitrate leaching and P runoff issues.

Secondary plant nutrients and micronutrients

To further understand the nutrient value of a manure source, growers may choose to order analyses of secondary plant nutrients and micronutrients as well. These additional nutrients include calcium (Ca), magnesium (Mg), sulfate-sulfur (SO_4-S), zinc (Zn), iron (Fe), and manganese (Mn).

Copper and soluble salts

Growers may want to consider analyzing manures and composts for copper (Cu) and soluble salts (electrical conductivity [EC]). Dairies that use copper sulfate footbaths may discard the copper into their manure management system, which can potentially increase copper concentrations in manures, composts, lagoon sludge, or lagoon water sources on a dairy. Copper testing can help to avoid copper toxicity issues in crops receiving dairy waste applications. Manures also contain significant amounts of salts (Na, K, Mg, Ca, and chloride [Cl] ions), which can cause salinity issues and even yield losses in fields receiving manure applications. Testing for EC, which is an indirect measure of soluble salts, can help a grower to know whether to anticipate a salt issue. EC testing is important in arid regions, where salt accumulation is more likely to be a problem.

Total carbon

An analysis that is commonly included with total N is total carbon (C). If total N is analyzed using the widely adopted combustion technique, then total C will also be measured and likely included on the analysis report. Total C values are often combined with N as the carbon-to-nitrogen ratio (C:N). C:N ratios can be useful for understanding the carbon contribution of the compost manure, the potential for N fertilizer immobilization, and the overall quality of the compost or manure. For more information on C:N ratios and composts, refer to *Compost: Production, Quality, and Use in Commercial Agriculture* (CIS 1175) and *Dairy Compost Production and Use in Idaho: The Composting Process* (CIS 1179) from University of Idaho Extension.

Converting units in lab results

At times, a manure testing lab may report results as percent nutrient content on a dry-matter basis, while a grower may be more interested in understanding the pounds of nutrient per ton of manure as is, or vice

Table 2. Unit conversions for manure or compost nutrient analyses.

	Lab units	Desired units	Conversion
(1)	% nutrient, dry weight basis	lb/ton, as received*	lb/ton = % nutrient × % dry matter × 0.2 or lb/ton = % nutrient × (100 – % moisture) × 0.2
(2)	lb/ton, as received	% nutrient, dry weight basis	$\% \text{ nutrient} = \frac{\text{lb/ton} \times 5}{\% \text{ dry matter}}$ or $\% \text{ nutrient} = \frac{\text{lb/ton} \times 5}{100 - \% \text{ moisture}}$
(3)	ppm nutrient, dry weight basis**	lb/ton, as received	lb/ton = ppm nutrient × % dry matter × 0.00002 or lb/ton = ppm nutrient × (100 – % moisture) × 0.00002
(4)	lb/ton, as received	ppm nutrient, dry weight basis	$\text{ppm nutrient} = \frac{\text{lb/ton} \times 50{,}000}{\% \text{ dry matter}}$ or $\text{ppm nutrient} = \frac{\text{lb/ton} \times 50{,}000}{100 - \% \text{ moisture}}$

*"as received" is also referred to as "wet weight basis"

**ppm (parts per million) is the same unit as mg/kg and ug/g versa. Equations are included in table 2 to help convert typical nutrient analysis units used by both labs and by growers. Example calculation 1 shows a conversion from "dry basis" to "as received."

Nutrient availability

The most important thing to understand about manure and compost nutrient analyses is that all of the nutrients are not immediately plant available. For example, organic N compounds in field-applied dairy manure or dairy compost must be converted to plant-available forms of N by microbes, which can take 3 or 4 years or longer. General estimates for nutrient availability following a recent dairy manure or dairy compost application are listed in table 3. Example calculation 2 shows how to calculate plant-available nutrients from the lab analysis. For more information on estimating nutrient availability of animal manures and composts, refer to *Estimating Plant Available Nitrogen from Manure* (EM 8954-E) from Oregon State University Extension Service.

Table 3. Nutrient availability to plants in the first growing season following application.

Component	Stockpiled dairy manure	Dairy compost
Nitrogen	0 to 20%	-5 to 10%
Phosphorus	70 to 90%	70 to 90%
Potassium	80 to 100%	80 to 100%

Example Calculation 1:

Lab manure analysis for a dairy compost.

Nutrient analyzed	% Nutrient (dry basis)
Total N	0.82
P_2O_5	0.85
K_2O	1.61
% Dry matter	74.7

What are the nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) values of this compost on a lb/ton (as received) basis?

Nutrient	% Nutrient (dry basis)		% Dry matter		Conversion factor (from table 2, equation [1])		lb/ton (as received)
Total N	0.82	X	74.7	X	0.2	=	12.2
P_2O_5	0.85	X	74.7	X	0.2	=	12.7
K_2O	1.61	X	74.7	X	0.2	=	24.1

Example Calculation 2:

Lab manure analysis for a dairy compost.

Nutrient analyzed	lb/ton (as received)
Total N	12.2
P_2O_5	12.7
K_2O	24.1

How much of the nutrients in the dairy compost is plant available in the first growing season following application?

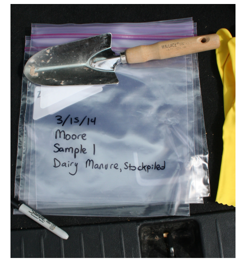
Nutrient	lb/ton (as received)	% Nutrient available (table 3, dairy compost column)	Lower estimate for available nutrient (lb/ton)	Upper estimate for available nutrient (lb/ton)
Total N	12.2	-5 to 10	-0.6	1.2
P_2O_5	12.7	70 to 90	8.9	11.4
K_2O	24.1	80 to 100	19.3	24.1

Instructions for Sampling Stockpiled Manure or Compost

Step 1. *Gather materials.*

- Clean plastic bucket (avoid metal buckets, which can influence metal concentrations in the lab analysis)
- Plastic, gallon-sized resealable bags (2 or 3 per sample)
- Permanent marker
- Dishwashing or laboratory nitrile gloves
- Shovel

- Optional: trowel, small tarp, cooler, ice packs



Prelabel two or three bags per sample with date, location, and manure/compost information. Put on gloves to avoid pathogen contamination.

Step 2. *Sample the pile.*

Manure. Find locations in the pile that have a representative mix of manure and plant residues. Take a sample from a depth of 12 inches at a minimum of 8 locations throughout the pile, and place these subsamples in the same bucket. The subsamples should be moist and have a mixture of manure and residues.

Compost. Compost piles require a minimum of 6 subsample locations per pile, due to the greater uniformity of compost compared to manure. Otherwise, follow instructions for manure sampling.

Step 3. *Mix the sample.*

For thorough mixing, dump the manure or compost onto a small tarp or dry ground. Use the shovel to mix the sample and to break up large manure clods. Smaller clods (2 inches or smaller) are okay. If the bucket is less than half full, the manure or compost may be mixed in the bucket instead.

continued on next page

Step 4. *Bag the sample.*

Using a trowel or gloved hand, collect 6 small subsamples from various spots throughout the composite sample and place them in the labeled plastic bag. Place the sealed sample into a second or even third labeled bag to prevent spillage and odors. Keep samples cool (but not frozen) until they are submitted to a lab for analysis. Coolers, ice packs, refrigerators, and overnight shipping services may be used to prevent samples from overheating.

Resources

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