Compost Management

Compost Analysis for Available Nutrients and Soil Suitability Criteria and Evaluation

Note: The following pages on " Nutrient Identification" analysis, are data conceived and developed by A&L Canada Laboratories and their affiliates: specifically for the Compost Industry.
The use of this analysis is now available for those wishing not to just maintain, but to advance in the quest for quantifying the value of their compost as a growth media.

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Introduction

Composting materials turns unusable solid waste into a valuable resource as a soil amendment provided the composting is done properly.

To obtain good quality compost it is important that certain quality control measures are in place to ensure a usable finished product. Poorly composted materials or immature compost can be very harmful to plant growth when added to the soil or used as a potting media

Maintaining a consistent raw material source will help in simplifying the process but routine sampling of the raw material will identify any inconsistencies so that adjustments can be made to the mix. Once the parameters of the raw materials are known proper blending following the basic principle of compost management will ensure uniform quality product.

> ### Composting Basics
>
> **"Composting" means the controlled decomposition (decay) of organic material such as yard trimmings, kitchen scraps, wood shaving, cardboard, and paper.**
>
> **Compost contributes nutrients and beneficial life to the soil, improves soil structure, and helps prevent runoff that can pollute rivers and lakes.**
>
> **"Compost" is the humus-rich material that results from composting. Compost contains humic substances that increase microbial activity and may depress resident (root) pathogenic fungi. Compost at the same time stimulates an increase in the numbers of beneficial (Mycorrhiza) fungi in soils that aid in the uptake of nutrients.**
>
> **Compost helps the soil absorb and retain nutrients and moisture, and protects plans from disease and pests. Better moisture retention means less watering, allowing you to conserve water and reduce runoff pollution.**

BENEFITS OF COMPOSTING

Compost contains a full spectrum of essential nutrients for plant growth. Although Compost is not a fertilizer, it is a growing media when used as an amendment to existing soil intended to improve the overall fertility and tilth of the soil. Compost should be analyzed for its nutrient content prior to use so that nutrient levels can be identified and the compost used in the right application.

Compost releases its nutrients slowly, over several months or years. Soils that are enriched with compost improve soil tilth, moisture holding capacity and adds organic life to the soil. Compost buffers soils in that it balances both acid and alkaline soils, bringing pH levels into the optimum range for nutrient availability.

Compost increases the soil's ability to retain water, and decreases its potential runoff. A five percent increase in organic matter quadruples the soil's ability to store water. Compost promotes healthy root growth, as well as decreases the need for chemical pesticides because it contains beneficial microorganisms that protect your plants from diseases and pests.

Soil Life

Compost introduces and feeds diverse life in the soil, including bacteria, insects, worms , and more which support plants growth. Compost bacteria and fungi break down mulch and plant debris into plant– available nutrients. Some soil bacteria also convert nitrogen from the air into a plant-available nutrient. Beneficial insects, worms and other organisms are plentiful in compost-enriched soil. They burrow through the soil keeping it loose and well aerated. Compost suppresses diseases and harmful pest that overrun poor, lifeless soil.

The Composting Process

Composting is the aerobic, or oxygen requiring, decomposition of organic materials by microorganisms under controlled conditions. During the composting, the microorganisms consume oxygen (O_2) while feeding on organic matter. Active composting generates considerable heat as well as large quantities of carbon dioxide (CO_2) and water vapor are released into the air. CO_2 and water losses can amount to half the weight of the initial materials. Composting thus reduces both the volume and mass of the raw materials while transforming them into a valuable soil conditioner.

Composting is most rapid when conditions that encourage the growth of the microorganisms are established and maintained (see table 1a). The most important conditions include:

> Organic materials appropriately mixed to provide the nutrients needed for microbial activity and growth, including a balanced supply of carbon and nitrogen (C:N ratio).
>
> Oxygen at levels that support aerobic organisms.
>
> Enough moisture to permit biological activity without hindering aeration.
>
> Temperature that encourages vigorous microbial activity from thermophilic microorganisms.

Many aspects of composting are inexact. The process occurs over a wide range of conditions and with many materials. The speed of composting, and the qualities of the finished compost are largely determined by selection and mixing of raw material.

Feedstock Testing

Quality Parameters of Feed Stock for Rapid Composting (*table 1a*)

Condition	Reasonable Range [a]	Preferred range
Carbon to Nitrogen (C:N) ratio	**20:1-40:1**	**25:1-30:1**
Moisture Content	**40-65% [b]**	**50-60%**
Oxygen concentrations	**Greater than 5%**	**Much Greater than 5%**
Particle size (inches)	**1/8/-1/2**	**Varies [b]**
pH	**5.5-9.0**	**6.5-8.0**
Temperature	**45-65**	**55-60**

a These recommendations are for rapid composting. Conditions outside these ranges can also yield successful results.

b Depends on the specific materials, pile size, and/or weather conditions.

These parameter are required to accurately calculate blends of raw compost

Tests Required to Monitor the Compost Process

Basic Monitoring Analysis

Temperature, Moisture, C:N Ratio, pH

Basic Monitoring Analysis Plus

Total nitrogen, Total Phosphorus, Total Potassium, pH, Organic Matter, C:N, Sodium, Moisture, Ash, Organic Carbon, Bulk Density.

Soil Suitability Testing of Compost

This test is the same one used for finished compost. The information on this test will help in understanding feedstock materials and blending to achieve the desired finished product.

Sampling Procedure See appendix D

Compost Quality Parameters for the CQA

pH - The measurement of soil pH is a measurement of the active acidity of the soil. The ideal pH of any product , particularly compost, should be neutral to slightly acidic (6.0 - 7.5). Although pH has no direct effect on plant growth as roots can obtain nutrients in soil slightly acidic to slightly alkaline. The concentration of calcium and other nutrients has a greater effect on plant growth. However nutrients required for plant growth are water soluble in soils with pH between 6 and 7.8. As pH goes much above this micronutrients and phosphorus become less available to roots. Likewise as pH drops below 5.5 many of the major nutrients become less available and some of the micronutrients can become toxic to the roots system. A pH between 5.5 and 8.5 is optimal for compost micro-organisms. As bacteria and fungi digest organic matter, they release organic acids. In early stages of composting, these acids often accumulate, The organic acids become further broken down during the composting process. If the system becomes anaerobic, however, acid accumulation can lower pH to 4.5, severely limiting microbial activity. In such cases aeration usually is sufficient to return the compost pH to acceptable ranges.

Carbon to Nitrogen Ratio (C/N)

Of the many elements required for microbial decomposition, carbon and nitrogen are the most important. Carbon provides both an energy source and the basic building blocks making up about 50% fo the mass of microbial cells. Nitrogen is a crucial component of the proteins, nucleic acids, amino acid, enzymes and co-enzymes necessary for cell growth and function.

It is customary to use C:N ratios to asses the rate of decomposition of compost mixtures, and in some cases but not all C:N may accurately reflect when maturity has been reached. C:N ratios may go up and down during the last stages of composting and most compost is considered finished when C:N ratio is in the range of 12-22 unless coarse woody materials are used in the raw feed stocks and are still present.

The ideal C:N ratiofor compost ingredients is around 30:1. Much below that nitrogen will be supplied in excess and will be lost as ammonia gas, causing undesirable odors, higher C:N mean that there is not enough nitrogen for optimal growth of the microbial populations, so the compost will remain relatively cool and degradation will proceed at a slow rate.

(table 1b)

Material High in Carbon	C/N Ratio
autumn leaves	30-80:1
straw	40-100:1
wood chips or sawdust	100-500:1
bark	100-130:1
mixed paper	150-200:1
newspaper or corrugated cardboard	560:1
Materials High in Nitrogen	
vegetable scraps	15-20:1
coffee grounds	20:1
grass clippings	15-25:1
manure	5-25:1

Moisture

Moisture content is one of the key elements of good composting that must be managed along with C:N, temperature, aeration etc. . Too much moisture, and the composting pile can become anaerobic, too little moisture and microorganisms that make composting work become dehydrated and die off.

The initial moisture content for composting is between 50 and 65%, and the final moisture content of mature compost in most applications is between 35-40%. Much below this and the compost will become dusty, however compost in a bag with moisture over 35% may begin to produce molds or become anaerobic.

Soluble Salts (EC)

Soluble salt or electrical conductivity (EC) of a media is a measurement of the total salt content in the media. This measurement is a total of both good salts (potassium, magnesium, calcium, nitrates and ammonia) and bad salts or salts that are much more toxic to plant life such as sodium and chlorides. Total EC may be high as a result of salts such as potassium and or calcium and cause plant damage but if diluted is an excellent source of these elements. However if total salts are high due to sodium or chlorides or even ammonia these are toxic to roots and very damaging. Sodium itself can be high enough in media to cause damage without causing a high reading in total salts.
Therefore in order to have a true understanding of potential salt injury both EC and sodium readings are necessary. *(table 1c)*

		Soluble Salt (EC)
Very low	**0-.75**	May be used as a planting media directly, will require some nutrient addition for plant growth.
Acceptable	**.75-2.0**	May be used directly as a media for small plants and seeding.
Medium	**2.0-3.5**	May be used for transplanting potted plants and mature plants with high nutrient demand. In applications with tender plants may need to be diluted with 25 to 50% soil.
Medium high	**3.5 - 5**	Can be used for topdressing established plants or blended in as a soil amendment to gardens or soils 2-1 to 5-1.
High	**5 - 10**	Used as a soil amendment and will require diluting with existing soil depending on the use 4-1 up to 10-1 for more sensitive plantings.
Very high	**>10**	Use only at low application rates in areas of plantings that do not have salt sensitivity.

Sodium (Na)

Plant injury resulting from excessive soluble salts or sodium may first occur as a mild chlorosis of the foliage, later progressing to a necrosis of leaf tip and margins. This type of injury is largely attributed to the mobility of soluble salts within the plant. As these salts are rapidly translocated throughout the plant they accumulate at the leaf tips and margins. Once the salts reach a toxic level they cause the characteristic "burn" associated with excessive salts. Roots injured by salts cause interference with nutrient and water uptake and results in excess wilting and poor growth. Often salt injury to roots will predispose the plant to a wide range of root diseases such as phythium, fusarium etc.

Sodium cont'd

Only a few plant species can tolerate high sodium levels and for the most part sodium levels greater than 1% saturation in media are toxic to root systems. Sodium competes with calcium and potassium uptake and damages root tissue when in excess. A reading of greater than 1% saturation of sodium on the exchange complex causes germination and emergence problems for a number of plants. This indication of sodium availability will suggest possible damage to plant growth long before a calculated SAR may suggest problems.

Finished Compost Testing

Testing the final product for environmental parameters is mandatory and goes without question. However the final product should be tested for its quality as it applies to end use. In most cases compost is used to support some sort of plant life in many applications from topdressing to soil remediation. A compost may pass all the mandatory criterion for environmental concerns and still be worthless to the end user. A&L has designed a test (S8C) that will assist in the interpretation of the analysis of the finished compost in it's ability to support plant growth.

Routine testing of Compost feed stocks is also a good idea so that recipes for blends can be made, looking at C:N ratio combinations that will work the best and identifying possible contaminates that may be present. Feed stock testing need not be as intensive but again will help to identify materials that work best in the final blend. (see compost fee schedule for descriptions of test and pricing).

ENVIRONMENTAL HEALTH	QUALITY	AGRONOMIC
Environmental & health related Criteria	Product Quality Criteria	Non government regulated or recommended criteria
TESTS	Describes the Characteristics of The Compost produced	Relates to the plant available nutrients including phytotoxic levels
Environmental Analysis	C:N	pH
Organics	Organic Matter	Organic matter
Health related analysis,/ microbiology, pathogens	Total nutrient elements	Plant Available elements and ranges
	Nitrogen	Nitrate Nitrogen
	Moisture	Moisture
	Soluble Salts	Soluble Salts
	pH	C.E.C.
	NBD	Base saturation of cations
	WHC	Proportional equivalent of cations
	Particle size	Cation ratio
		Na and %Na
		C:N
		Lime index

INTERPRETATION OF

ORGANIC SOIL AND COMPOST ANALYSIS

Our Compost Analysis was researched and developed by A&L Canada Laboratories and North Carolina State testing laboratories in cooperation with Rose Growers Inc. of the US. This analysis is specifically designed to analyze soil that contains more than just peat material. This would include composted materials, peat, and soil mixtures, greenhouse mixes, potting soil mixes, and organic material used as feedstock that may be used in the composting process.

This analysis unlike the Saturated Paste method will extract nutrients that are contained in the mineral portion of these soils and mixes which gives us a more precise interpretation of nutrient availability over the growing season. Extensive field calibration has been done to support this information.

Our Organic Analysis for lime pH is different than SMP. We use this number to calculate an acidity number using a specific buffer test developed to give a more precise value for the addition of lime material to correct pH and calcium deficiencies.

OPTIMUM pH FOR VARIOUS SOIL TYPES

SOIL CLASS	TARGET Ph
Mineral Soil	6.5
Mineral Organic Soil	5.5
Organic Soil	5.2 (5.0-5.5)

pH requirement may vary depending on the crop that is to be grown

LIME REQUIREMENT = AC X FACTOR—RESIDUAL LIME CREDIT

1. **AC= 4(6.6 — LIME INDEX)**
2. **FACTOR =** $\frac{\text{desired pH — Soil pH}}{\text{6.6 — pH of Soil}}$

Residual credit (RC) for lime applied prior to soil test. RC is reduced by 16%/month, from the time of application to time of soil test for mineral or organic soil.

INTERPRETATION OF DATA (COMPOST ANALYSIS REPORT)

Each set of results has a chart for interpretation of ppm rating. It also has a calculation of CEC and % saturation which are broad ranges across all soils The second line of values differentiate the specific type of unique properties of the compost. On the extreme right of the second line are listed the meq of the cations and ratios that are optimum.

OPTIMUM RANGES OF CATIONS

K 3-5% saturation

Mg 9-21% saturation

Ca 60-80% saturation

PROPORTIONAL EQUIVALENTS (meq) COMPARISONS OF THE CATIONS

K— The optimum range for meq of K is between 0.5 - 1.5 meq/100g. Levels less than 0.5 will need K added to support plant growth. Levels greater than 1.5 may contribute to a soluble salt condition that can restrict root growth and cause plant injury.

Mg— 1.2-8 meq/100g is the ideal range. Mg to K should be 7:1 for optimum availability of each nutrient.

Ca— 8-13 meq/100g is ideal for compost. The relationship of Ca to Mg should be 5:1

Na— Levels less than 1% saturation are ideal. Root growth will be very restricted if plants are grown in material with sodium levels greater than 1%. Material with sodium greater than 1% and less than 3% should be blended or have the sodium leached out using water and gypsum.

CALACULATION OF CEC

ppm Ca/2.00 + ppm Mg/1.26 + ppm K/3.9 + AC value = CEC

In our analysis we use all three interpretations of the data to determine the nutritional status of these soils. All values may not agree and we rate the value on the determination in the following manner.

The least important rating is the ppm value of the nutrients. This rating is too broad and usually not specific enough to truly determine this media's characteristics.

The % saturation of the cations is next in importance. This is a better determination of this media's value but it is still too broad.

The most important is the meq ratio comparison of the cations. This interpretation picks out the unique characteristics of a particular media.

NUTRIENT RANGES OF ORGANIC SOILS

DETERMINATION	LOW	MEDIUM	OPTIMUM	HIGH	VERY HIGH
Soluble Salts	0-.75	.75-2.0	2.0-3.5	3.5-5.0	>5.0
Nitrate N	0-39	40-99	100-199	200-299	>300
Phosphorus	0-30	31-60	61-90	91-150	>150
Potassium	0-50	51-100	101-145	146-250	>250
Calcium	0-400	400-600	600-1000		
Magnesium	0-120	120-150	150-300		

Micronutrient Ranges

Very low	Low	Medium	Good	High	Very high
Manganese					
0-10	10-15	16-30	30-45	45-100	>100
Copper					
0-1.5	1.5-6	7-12	13-18	19-25	>25
Boron					
0-0.5	0.6-1.5	1.5-2.4	2.5-3	3-6	>6
Zinc					
0-2	2-3	3-5	5-8	8-10	>11
Sulfur					
0-5	5-10	10-20	20-30	30-40	>40

MANGANESE RECOMMENDATIONS FOR ORGANIC SOILS lbs/ac

pH

Mn ppm	5.8	6.0	6.2	6.4	6.6	6.8	7.0+
3	2	4	5	7	9	10	12
6	1	3	5	6	8	10	11
12		1	3	5	7	8	10
18			2	4	6	7	9
24			1	3	4	6	8
30				1	3	5	6
36					2	4	5
43					1	2	4
49						1	3
55							1

ZINC RECOMMENDATION FOR ORGANIC SOILS lbs/ac

pH

Zn ppm	6.6	6.8	7.0	7.2	7.4	7.6+
1	1	2	3	4	5	6
2		1	2	3	4	5
4			1	2	3	4
6			1	2	3	4
8				1	2	3
10					1	2
12						1

COPPER RECOMMENDATIONS FOR ORGANIC SOILS

Cu ppm	Lb Cu per acre
1.5	4
6	4
12	3
18	2
25	1
25+	0

Compost Quality Alliance (CQA)

The "Compost Quality Alliance" is a voluntary program established by the Composting Council of Canada and the compost producers utilizing standardized testing methodologies and uniform operating protocols to improve customer confidence in compost selection and utilization.

Compost Testing Frequency for (CQA)

Annual Compost Production	Frequency of Testing
1 to 5,000 tonnes	4 samples during production season
5,000-15,000 tonnes	6 samples during production season
More than 15,000 tonnes	12 samples during production season

(table 3a)

CQA Product Quality Test Requirements

USE	pH	C/N ratio	Moisture	Particle size	Soluble salts	%Na
Remediation	5.8-8.5	10-40	NA	<2 inch	<20	<3%
Soil Amendment	5.8-8.5	10-30	NA	<1/2 inch	<6	<2%
Landscaping	5.8-8.5	12-22	<50%	<1/2 inch	<5	<2%
Planting Media	5.5-7.8	12-22	<50%	<1/2 inch	<4	<2%
Turf Topdressing & establishment	5.8-7.8	12-22	<50%	<3/8 inch	<3	<1%
Potting Soil	5.5-7.2	12-22	<50%	<1/4 inch	<2	<1%

(table 3b)

Appendix A
QUALITY PARAMETERS FOR FINISHED COMPOST

	DESIRABLE VALUES
TOTAL NITROGEN	0-6%
TOTAL PHOSPHORUS	0.25%
TOTAL POTASSIUM	0.20%
CALCIUM	3.0%
MAGNESIUM	0.3%
TOTAL ORGANIC MATTER	>30
AVAILABLE ORGANIC MATTER	
CARBON/NITROGEN RATIO	12-22
TOTAL SALT CONDUCTIVITY	<3.5
SAR	<5
PH	5.5-8.5
MOISTURE	30-50
ARSENIC	<13 mg/kg
CADMIUM	<3.0
CHROMIUM	<210
COBALT	<34
COPPER	<400
LEAD	<150
MERCURY	<0.8
MOLYBDENUM	<5
NICKEL	<62
SELENIUM	<2
ZINC	<700
PCB	<0.5

QUALITY GUIDELINES Appendix B

END USE COMPOST

Potting Grade

Uses	Growing medium without additional blending
Colour	Dark brown to black
Odour	Should have a good fresh earthy odour
Particle Size	Less then 1/2 inch (13mm)
pH	5.2-7.2
Soluble Salts	Less than 2.0 mmhos per centimeter
Foreign materials	Less than 1% foreign material
Heavy metals	Should not exceed Compost Utilization Guidelines
Respiration Rate	Less than 200 (mg/kg/hour)

Potting Media (amendment grade A)

Uses	For formulating growing medium for potted crops with pH less than 7.2
Colour	Dark brown to black
Odour	Should have no objectionable odour
Particle Size	Less than 1/2 inch (13mm)
pH	Range should be identified
Soluble Salts	Less than 2.0 mmhos per centimeter
Foreign materials	Less than 1% foreign materials
Heavy metals	Should not exceed Compost Utilization Guidelines
Respiration Rate	Less than 200 (mg/kg/hour)

Top Dressing Grade

Uses	Principally used for topdressing turf
Colour	Dark brown to black
Odour	Should have no objectionable odour
Particle Size	Less than 1/4 inch (7mm)
pH	Range should be identified
Soluble Salts	Less than 3.0 mmhos per centimeter
Foreign materials	Less than 1% foreign materials
Heavy metals	Should not exceed Compost Utilization Guidelines
Respiration Rate	Less than 200 (mg/kg/hour

Soil Amendment Grade

Uses	Principally used for improvement and restoration of soils, pH adjustment and maintenance
Colour	Dark brown to black
Odour	Should have no objectionable odour
Particle Size	Less than 1/2 inch (13mm)
pH	Range should be identified
Soluble Salts	Less than 20 mmhos per centimeter
Foreign materials	Less than 5% foreign materials
Heavy metals	Should not exceed Compost Utilization Guidelines
Respiration Rate	Less than 200 (mg/kg/hour)

COMPOST USES Appendix C

Compost is a valuable resource for soil improvement. Compost is useful to the home gardener, in the restoration of landscapes where topsoil has been removed or compacted, and to restore agricultural and forest lands.

Using Compost as Mulch
On flower and vegetable beds: **-Remove weeds and grass that may grow through mulch** **-Screen or pick through compost to remove large, woody materials. They may be unattractive, and will compete for nitrogen if mixed into the soil.** **-Apply 1”-3” of compost over the entire bed, or place in rings around each plant that extend as far as its outermost leaves.** **-Always keep mulches a few inches away from the base of the plant to damage by pests and disease**
On Lawns: **-Use screened commercial compost, or sift homemade compost through a 1/2” or finer mesh.** **- Spread compost in 1/4”-1/2” layers after thatching, coring, or reseeding**
On Trees and Shrubs: **-Remove sod from around trees and shrubs as far as branches spread. If this is impractical, remove sod from within a minimum of 4’ diameter circle around plants.** **-Use coarse compost or materials left after sifting, Remove only the largest branches and rocks.** **-Spread 1”-3” of compost**
For Erosion Control: **-Spread coarse compost, or materials left after sifting, in layers 2”-4” deep over entire planting area or in rings extending to the drip line.** **-Mulch exposed slopes or erosion-prone areas with 2”-4” of coarse compost.**

Soil Amendment: Compost can be used to enrich garden beds before planting annuals, grown covers, shrubs and trees. Recommended applications for different plants are shown on the following chart. Amend soils by mixing compost thoroughly into the top 6”-12” of existing soil. Do not lay compost on top of the existing soil without mixing: the interface where they meet can become a barrier to penetration by roots and water.

Using Compost as a Soil Amendment
In flower and vegetable beds and ground covers: **-Dig or till base soil to an 8”-10” depth** **-Mix 1”-4” of compost through the entire depth. In established gardens, mix 1”-3” of compost into the top 6”-10” of soil each year before planting**
On Lawns: **-till base soil to a 6”-12” depth.** **-Mix 1”-2” of finely textured compost into the loosened base soil.**
Around Trees and Shrubs: **-Dig or till base soil to minimum 8”-10” depth throughout planting area, or an area 2-5 times the width of the root ball of individual specimens.** **-Mix 1”-4” of compost through the entire depth.** **-Do not use compost at the bottom of individual planting holes or to fill the holes. Mulch the surface with wood chips or coarse compost.**

Potting Soil and Seed Starting Mixes

Sifted compost can be used as part of a potting soil for use in planters, house plants, or starting seedlings in flats. Compost is a good component in potting soil: it stores moisture and supplies nutrients not found in sand, bark, peat and pumice.

> Use only very mature compost to avoid "burning" plants or tying up nitrogen in the soil. Water new plant until water runs out of the bottom of containers to wash out any harmful salts. Soluble salts should be less than 2 in this compost.
> Use compost to make up no more than 1/3 of the volume of a potting mix. Some simple "recipes" for making compost mixes are shown below.

Using Compost in Potting Mixes
For starting and growing seedlings in flats or small containers: **-Sift compost through a 1/4" screen or use compost that has been screened to 1/4".** **-Mix 1 part sifted or screened compost, 1 part coarse sand, and 1 part Sphagnum peat moss. Add 1/2 cup of lime for each bushel (8 gal.) of mix. Use liquid fertilizer when true leaves emerge.**
For growing transplants and plants in larger containers; **-Sift compost through 1/2" mesh or use screened compost.** **-Mix 1 part compost; 1 part ground-up bark, perlite or pumice; 1 part course sand; and 1 part loamy soil or peat moss. Add 1/2 cup of lime and 1/2 cup of 10-10-10 fertilizer for each bushel (8 gal.) of mix. (An organic fertilizer alternative can be made from 1/2 cup bloodmeal or cottonseed meal, 1 cup of rock phosphate, and 1/2 cup of kelp meal.**

Sample Collection
Appendix D

1. Introduction

Compost is typically heterogeneous (i.e. varying composition throughout) in nature. Proper sample collection is critical to achieve meaningful analytical results. The goal during sampling is to collect a representative sample. A representative sample is reflects the average nature of the compost that is being sampled.

Important aspects to keep in mind while collecting a sample include:

- Collection of a number of increments (i.e. sub-samples)
- Use of sampling apparatus that will not have an impact on analytical results
- Use of proper sample container, labeling procedures and storage procedures
- Provision of appropriate instructions to the laboratory that will be undertaking analysis.

There are two good quality sources of information on compost sample collection:

Document	**Comments**
BNQ Standard (section 8)	Overview of basic sample collection protocol
Test Methods for the Examination of Composting and Compost (TMECC) (Section 02.01 pages 1-12.	More detailed overview of sample collection

Both of these sampling methodologies are on the CQA web-site.

2. Overview of Sample Collection

There is a description of sampling in Section 8 of the BNQ Standard. The sampling protocol presented below uses this description as a basis and starting point with additional information provided to facilitate efficient sampling.

2.1 Apparatus

i. The apparatus used to collect the sample should not be made of materials that can affect the characteristics of the compost being sampled.

ii. Suggested collection equipment includes a metal shovel, a calibrated container having a capacity of 1 litre, 5 gallon pail (22 litre) and a square rubber or plastic sheet for the collection of increments.

iii. Samples should be placed in clean and airtight containers. Examples include sealable plastic bags (e.g. Ziplock) and sealable rigid plastic containers

2.2 Sampling Method

2.2.1 General

i. **Increments** (i.e. sub-samples) used to form samples should be taken at random in a pile of compost.

ii. Sampling should be conducted within 1-2 hours to avoid undue exposure of the compost sample and potential loss or absorption of moisture.

2.2.2 Volume and Number of Increments

i. Prior to sampling select a starting point, measure the **perimeter** of the lot by pacing from the starting point. One pace equals approximately 1 metre.

ii. For compost piles of 5,000 m^3 or less collect **10** increments.
For compost piles of between 5,000 m^3 and 10,000 m^3 collect **20** increments.
For compost piles greater than 10,000 m^3 collect **40** increments.

These are the minimum number of **1-2 litre increments** that need to be collected.

2.2.3 Where to Collect Samples from a Compost Pile

To determine where in the compost pile to collect increments a distance interval can be calculated.

i. A **distance interval** is calculated by dividing the number of **increments** into the **perimeter.**

ii. The **distance interval** is paced by foot for each increment to be collected.

2.2.4 How to Collect Increments (Samples) from a Compost Pile

i. Increments should be collected alternately from the top, middle and bottom of the pile of compost at a depth of 50cm, after a depth of 10cm of compost has been removed from the surface of the pile.

ii. Increments (1-2 litres) should be collected using a shovel and placed in a 5 gallon or similar pail(s).

iii. Repeat increment collection until the required number has been collected.

Example

A compost pile has a perimeter of 100 metres and a volume of 750 m^3.

i. How many **increments** (i.e. sub-samples) are required?
ii. What is the **distance interval** between the **increments** to be collected?

Answer

i. The compost pile is less than 5,000 m^e and therefore 10 **increments** should be collected
ii. The **distance interval** is 100 metres/10 increments= **10 metres**
iii. Figure 1 depicts distance intervals and increment collection points

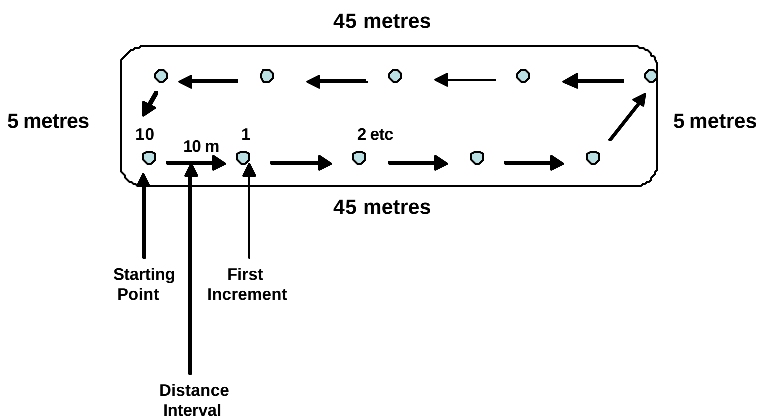


Figure 1. Overhead view of a compost pile and a schematic of increment (sample) collection Including distance intervals and increment collection points

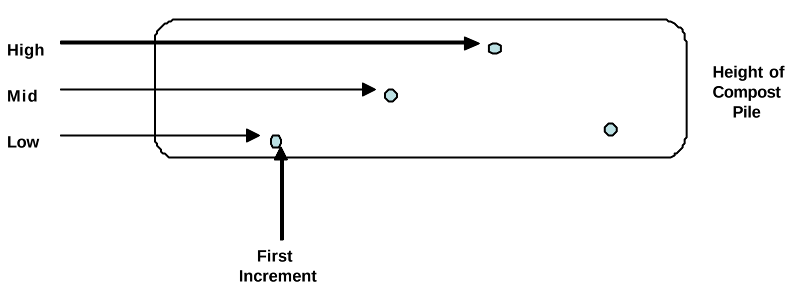


Figure 2. Side view of a compost pile with a schematic of the location of increment collection

2.3 Formation of a Representative Sample

Not of all the compost from the increments collected will be sent to the laboratory for analysis. The representative sample should represent the average of the increments collected. In short the compost increments collected will need to be mixed. A sample to send for laboratory analysis will be extracted from the mixed pile of increments.

2.3.1 Mixing of Increments and Quartering

Increments are mixed. A sample to send to the laboratory is extracted using a method called quartering.

i. All increments collected should be placed on a rubber or plastic sheet and mixed thoroughly to form a sample. They can be mixed using a shovel or by hand (wear gloves)
ii. This sample should be reduced to a maximum size of 1-2 litres through quartering.

From Annex A of the BNQ Standard a summary of quartering is presented below.

i. Form compost sample to be reduced into a conical heap on a clean, dry, smooth surface.
ii. Flatten top of cone and divide the compost into four piles along two diameters at right angles to each other.
iii. Remove and discard two diagonally opposite quarters, leaving a clean surface in these free spaces.
iv. Mix the remaining quarters until the required test sample is obtained.

Figure 3a and 3b depict the formation of a representative sample to send to the laboratory.

2.3.2 Sending the Sample to a Laboratory

i. The representative sample should be placed in a clean, dry and labeled container (e.g. sealable plastic bag or rigid plastic container).
ii. The sample should be placed in a cooler or similar along with an ice pack. The sample should be stored at between 0-5 ^{o}C.
iii. An appropriate laboratory "Chain of Custody" sheet should be completed.
iv. The sample should be sent to the laboratory for analysis

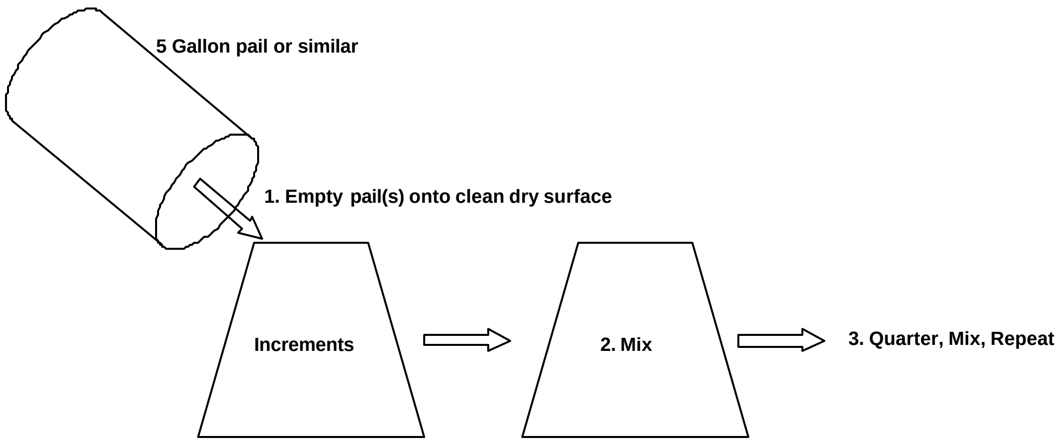


Figure 3a. Side view of formation of representative sample

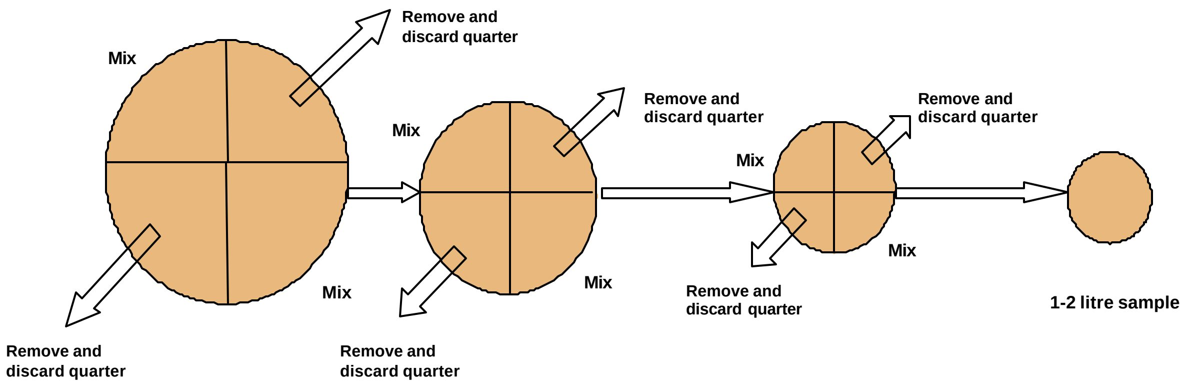


Figure 3b. Overhead view of quartering to prepare a representative sample

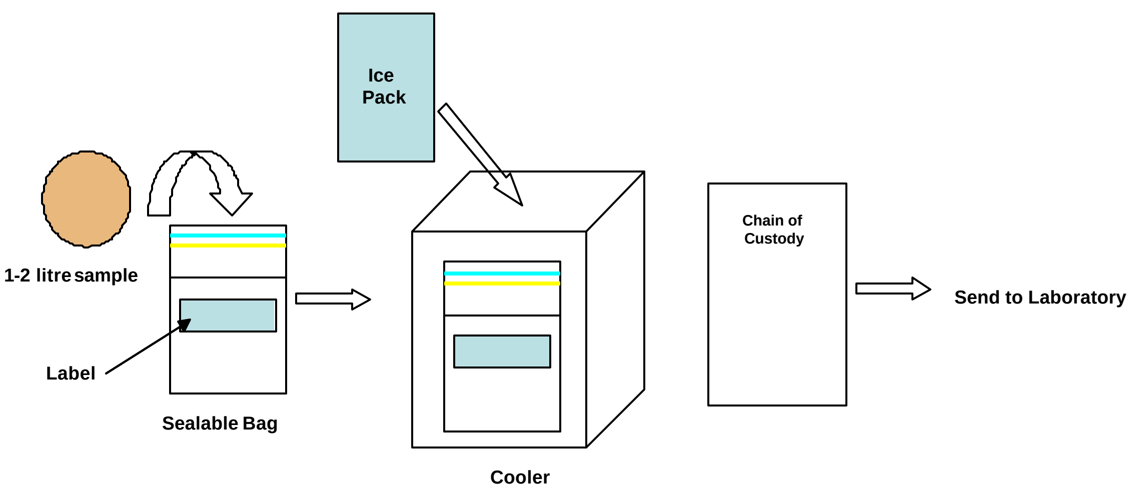
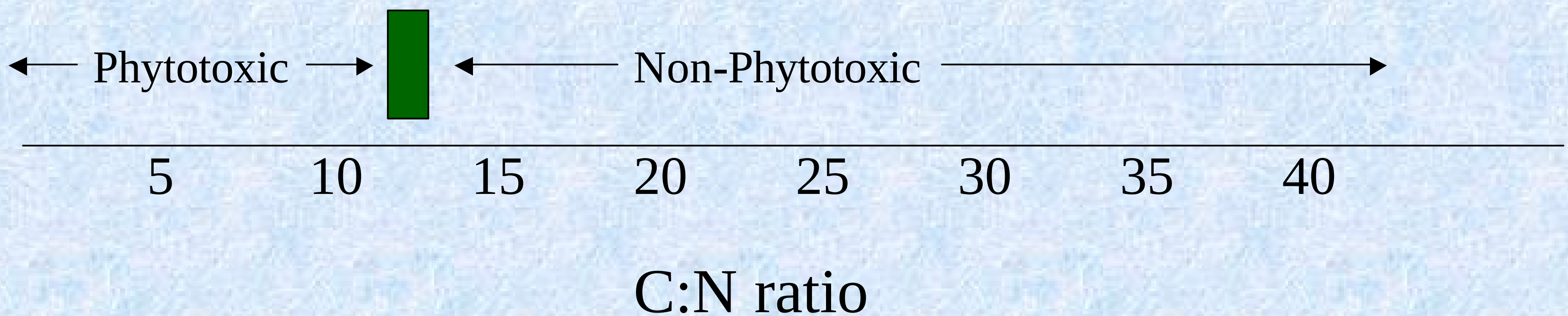
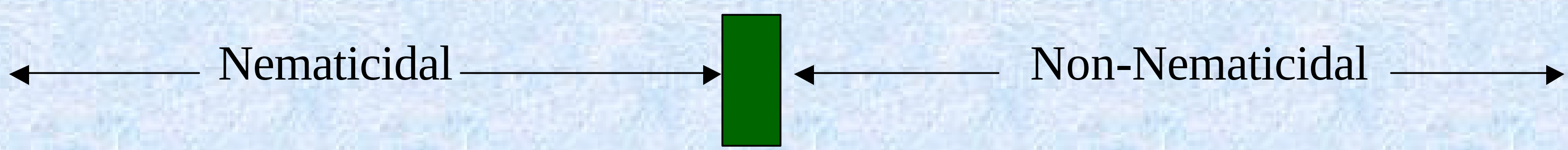


Figure 4. Schematic of preparing the sample to send to a laboratory

CARBON:NITROGEN RATIO



Carbon to Nitrogen ratio must be >12 and < 25



Schematic representation of the relationship between the C:N ratio of an organic amendment, nematicidal activity and phytotoxicity. (From Rodriguez-Kabana et al, 1987)

Trouble Shooting and Management Guide
Appendix F

Condition or Situation	Possible Source or Reason	Other Clues	Remedy
Compost fails to heat	Materials too dry	Cannot squeeze water from material	Add water or wet feed materials
	Materials too wet	Appearance looks soggy Pile slumps Moisture greater than 60%	Add dryer ingredients Remix the pile
	Not enough Nitrogen Slow composting activity	C:N Ratio is too wide >50:1 High fibre and wood content	Add higher Nitrogen contents Change recipe of ingredients
	Poor structure	Pile settles quickly Few large particles Not excessively wet	Add bulkier materials
	Cold weather, small pile	Pile height 3.5 feet	Enlarge or combine piles Add highly degradable mat
	pH excessively Low	pH is < than 5.5 Foul smelling activity	Add lime or wood ash Remix to incorporate
Temperature continues to fall with time	Low oxygen content Requires more aeration	Temperature declines slowly	Aerate pile More frequent mixing
	Low moisture content	Low moisture content	Increase water content
Uneven temperatures	Poorly mixed materials	Visible differences in materials	Remix the pile
Varying odors	Uneven distribution of airflow	Visible differences in moisture	Shorten the aeration pipe Remix the pile
	Uneven stages of decomposition	Temperature varies along	None
Gradually falling temperature	Composting near completion	C:N ratio approaching 20:1 Composting period over	None
Pile will not reheat Pile overheating (Temp.>150 F.)	Low moisture Insufficient aeration For heat dissipation	Cannot squeeze water Pile is too moist	Add water and remix Turn pile more frequently Increase the airflow
	Moderate to low moisture Limited evap. Cooling	Pile feels damp but not too damp or dry	Add more water Continue turning and aeration to control temperature
	Pile is too large	Height is > 8 feet	Decrease the size of the pile

Extremely high temp. (>170 F.)	Spontaneous combustion conditions exist	Low-moisture content Core area looks and smells charred	Decrease pile size Maintain adequate moisture content Add fresh material and remix
High Temp. and odors during curing	Compost is not stabilized	Short active composting Temp. and odor change after mixing	Monitor pile temp. closely Turn pile as required Limit pile size
	Piles are too large	Piles > 8 ft. in height	Reduce pile size to within maximum specifications
Ammonia odor coming from the pile	High Nitrogen pile content	C:N ratio is <20:1	Add higher fibre (carbon) ingredients to pile
	High pH levels in pile	pH is > 8.0	Lower pH using acidic material 'Reduce alkaline feed material
	Slower available Carbon source	Excessive large woody part C:N ratio exceeds 30:1	Incorporate smaller woody materials
Rotten Egg or putrid odors from compost	Anaerobic conditions	Low temperatures	
	Materials too wet		Incorporate dryer materials
	Poor structure		Add bulkier materials
	Pile is compacted		Remix pile and add bulkier materials
	Insufficient aeration		Continue turning & aeration to control temperature
	Anaerobic conditions	High temperatures	
	Piles are too large		Decrease the size of pile
	Airflow is uneven		Remix pile and change recipe
Odors generated after turning	Odorous raw materials	High temperatures	More frequent turning Increase the aeration
	Insufficient aeration Anaerobic core composting	Falling temperatures	More frequent turning Increase the aeration
Site related odors	Raw materials	Odor is characteristic of the raw materials	Process the raw materials upon receipt. Reduce storage
	Nutrient-rich puddles due to poor drainage	Standing puddles of water	Divert runoff away from storage
	Holding pond or lagoon overloaded with nutrients	Heavy algae and weeds gas bubbles on surface	Install sediment trap Enlarge size of pond area

Canadian Compost Guidelines (1996) for Compost Maturity, Pathogens, Aesthetics and Trace Elements
Appendix G

	CCME		CFIA		BNQ		British Columbia & Nova Scotia	
Classification Use	Category A All Aplications	Category B Restricted Use	Type B Restricted Use	Type AA	Type A	Type B	Code 1 Unrestricted Use	Code 2 Restricted Use
Maturity Tests								
C/N Ratio	< 25	< 25	< 25	< 25	< 25	< 25		
Oxygen Uptake	< 150 O2/kg/hr	< 150 O2/kg/hr	< 150 O2/kg/hr	< 150 O2/kg/hr	< 150 O2/kg/hr	< 150 O2/kg/hr		
Germination	Cress or Radish > 90%	Cress or Radish > 90%	Cress or Radish > 90%	Cress or Radish > 90%	Cress or Radish > 90%	Cress or Radish > 90%		
Foreign Matter (Non Biodegradable)								
Sharp Material	None > 3.0mm	None > 3.0mm	None > 3.0mm	None > 3.0mm	None > 3.0mm	None > 3.0mm		
Aesthetics (Max)	25mm	25mm	25mm	12.5mm	12.5mm	25mm	25mm	25mm
% of oven dried mass	N/A	N/A	N/A	< 0.01	< 0.5	< 1.5		
Plastic	N/A	N/A	N/A	N/A	N/A	N/A		
Other (total)	N/A	N/A	N/A	N/A	N/A	N/A		
Maximum Trace Heavy Metal Concentration Limits for Compost mg/kg								
Arsenic (As)	13.0	75.0	75.0	13.0	13.0	75.0	13.0	13.0 - 30.0
Cadmium (Cd)	3.0	20.0	20.0	3.0	3.0	20.0	2.6	2.6 - 10.0
Cobalt (Co)	34.0	150.0	150.0	34.0	34.0	150.0	26.0	26.0 - 100.0
Chromium (Cr)	210.0	N/A	N/A	210.0	210.0	1060.0	210.0	210.0 - 500.0
Copper (Cu)	100.0	N/A	N/A	100.0	100.0	757.0	100.0	100.0 - 250.0
Mercury (Hg)	0.8	5.0	5.0	0.8	0.8	5.0	0.8	0.8 - 5.0
Molybdenum (Mo)	5.0	20.0	20.0	5.0	5.0	20.0	5.0	5.0 - 20.0
Nickel (Ni)	62.0	180.0	180.0	62.0	62.0	180.0	50.0	50.0 - 200.0
Lead (Pb)	150.0	500.0	500.0	150.0	150.0	500.0	150.0	150.0 - 500.0
Selenium (Se)	2.0	14.0	14.0	2.0	2.0	14.0	2.0	2.0 - 6.0
Zinc (Zn)	500.0	1850.0	1850.0	500.0	500.0	1850.0	315.0	315.0 - 800.0
Pathogens (total solids calculated on a dry weight basis)								
Faecal Coliforms	< 1000 MPN/g	< 1000 MPN/g	< 1000 MPN/g	< 1000 MPN/g	< 1000 MPN/g	< 1000 MPN/g		
Salmonella	< 3 MPN/4g	< 3 MPN/4g	< 3 MPN/4g	< 3 MPN/4g	< 3 MPN/4g	< 3 MPN/4g		
Chemicals (mg/kg dry Weight)								
PCB								
Typical Mineral Content of a Good Quality Compost (Not Specifications)								
Total Nitrogen % dry wt.							0.60	0.60
Total Phosphorus % dry wt.							0.25	0.25
Total Potassium % dry wt.							0.20	0.20
Calcium % dry wt.							3.00	3.00
Magnesium % dry wt.							0.30	0.30
Organic Matter %							> 30.0	> 30.0
C/N Ratio							22.0	22.0
Total Salts mS/cm							< 3.5	< 3.5
SAR							< 5.0	< 5.0
pH							5.5 - 8.5	5.5 - 8.5
Moisture %							30 - 55	30 - 55
Water Holding Capacity							3 times dry wt.	3 times dry wt.