

Compost Maturity and Indicators of Quality: Laboratory Analyses and On-Farm Tests

Greg Evanylo

Ph: 540-231-9739
EM: gevanylo@vt.edu



Compost Quality Standards Developed by Composting Industry

- U.S. Composting Council (<http://compostingcouncil.org/index.cfm>)
 - Test Methods for the Examination of Composting and Compost (TMECC) laboratory manual
 - Seal of Testing Assurance (STA)
- Seals of Approval
 - Woods End Research Laboratory (<http://www.woodsend.org/>)
 - California Compost Quality Council (<http://www.crra.com/ccqc/ccqchome.htm>)

How is degree of decomposition assessed?

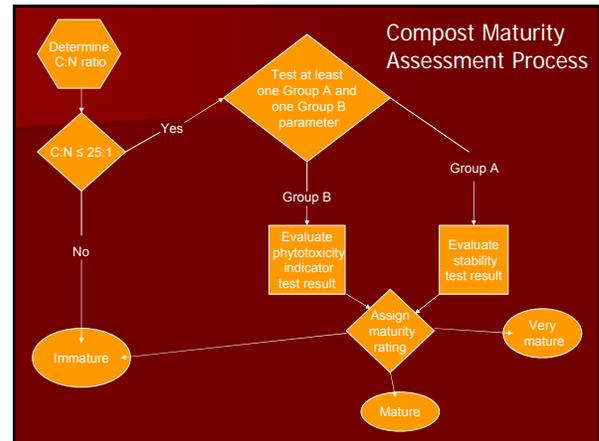
- Stability – Stage of composting process where microbial activity diminishes with a corresponding decrease of energy sources (viz., available organic carbon). Stability is sometimes related to compost color, which often changes from light brown to dark brown/black as biological activity subsides.
- Stability Index - The level of microbial activity in a sample based on respiration monitoring.

How is quality for use determined?

- Phytotoxicity (often confusingly termed maturity) – Caused by the presence or absence of organic chemicals in stable compost that impair plant growth. Organic phytotoxic chemicals may include lactic acid (“sour milk”) and acetic acid (“vinegar”).

Compost Maturity Index

Very mature	Mature	Immature
Well cured compost	Cured compost	Uncured or raw compost
No continued decomposition	Odor production not likely	Odor production likely
No toxicity potential	Low toxicity potential	High toxicity potential
No impact on available soil N	Low impact on available soil N	High impact on available soil N



Compost Maturity Index Parameters

Carbon Nitrogen Ratio (C:N)	
Group A (stability)	Group B (phytotoxicity)
Respirometry tests: <ul style="list-style-type: none"> Specific O₂ uptake rate (SOUR) CO₂ evolution Dewar self-heating test Solvita CO₂ 	Ammonium (NH ₄) <ul style="list-style-type: none"> NH₄-N:NO₃-N Solvita NH₃ Volatile fatty acids (VFAs) Biological assays: <ul style="list-style-type: none"> Emergence & seedling vigor In vitro germination and seedling elongation

Assessing Stability



Respirometry



Self-heating

Respirometry Stability Classes

Group A (stability)	Rating		
	V. stable	Stable	Unstable
SOUR (mg O ₂ /g OM/d)	<3	3-10	>10
CO ₂ evolution rate (mg CO ₂ -C/g OM/d)	<2	2-4	>4
Dewar self-heating test (Dewar index)	V		<V
Headspace CO ₂ (color code for Solvita CO ₂)	7-8	5-6	1-4

Assessing Maturity: Solvita Quick Test



Cress (*Lepidium sativa*) Test

Approved by: Swiss Compost Association, German Compost Association, and Woods End Laboratory & Rodale Quality Seal.

Most widely recognized plant species for compost bioassays:
 - moderately sensitive to salinity
 - insensitive to auxinic herbicides



Control (Pro-Mix)

Compost

Cucumber Test (USCC TMECC)

Not a compost maturity indicator:
 - fungal pathogens
 - soluble nitrogen (ammonia + nitrate)



Control (Pro-Mix)

Compost

Tomato Test

- Moderately sensitive to maturity factors
 - Somewhat insensitive to salts
 - Responds to soluble nitrogen & potash levels

Useful for testing composts used as seedling starters and potting mixes.



Control (Pro-Mix)

Compost

Top Growth Study

Growth Series: 0-20-40-80-100% manure compost with soybeans, which are sensitive to salt stress, trace element toxicity and auxinic herbicides.



Compost had 8 dS/M (mmhos/cm) conductivity which limits its use to 15-20% addition.

Root Growth Study

Growth Series: 0-25-50-100% MSW compost with sorghum-sudangrass. 21 day trial.



Root inhibition from moderately immature (high VFA content) compost with elevated soluble salts level began after 25%.



Oxygen Stress:
 Major effect of immature compost on plant development

Roots from 60-day container studies reveal the effect of oxygen deprivation from immature compost.



Incompletely composted biosolids (Day 21-97-250-Control) induces root inhibition through 97 days of composting.

Excised rootlets:
 - Left (Control)
 - Right (O₂-deprived)

Herbicide Residues in Compost



- Herbicide-like injuries (2000-2002)
 - Tomatoes (Spokane)
 - Vegetables (WSU)
 - Vegetables (PSU)
- Traced to compost produced from yard trimmings, livestock manure & bedding

Leaves cupped or curled

Leaves should be compound

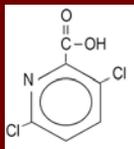
Loss of apical dominance

Side shoots develop



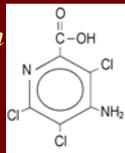
Properties of Clopyralid and Picloram

- Pyridine carboxylic acids
- Mimic plant growth regulators (auxins)
- Very water soluble
- Effective at low conc's (<10 ppb soil)



Clopyralid

Picloram



Herbicide Residue Bioassays



Detail: Leaf curl in red clover (*Trifolium pratense*) at low herbicide levels.

Red clover is sensitive in the range 3-50 ppb, but soluble salts may interfere with interpretation.

Phytotoxicity Thresholds

Group B (Phytotoxicity)	Phytotoxicity Rating		
	None	Low	High
NH ₄ (mg/kg dw)	<75	75-500	>500
NH ₄ -N:NO ₃ -N	<0.5	0.5-3.0	>3.0
Seedling emergence & vigor (% of control)	>90 & >95	80-90 & 85-95	<80 & <85
In vitro germ. and root elongation (% of control)	>90	80-90	<80
NH ₃ (Solvita NH ₃ color code)	5	4	1-3
VFAs (mmoles/g dw)	<200	200-1000	>1000

Maturity Assessment Matrix

		Group B Outcome (phytotoxicity rating)		
		None	Low	High
Group A (stability rating)	V. Stable	Very mature	Mature	Immature
	Stable	Mature		
	Less stable	Immature		

Physical Properties of Compost

Property	Common units	Significance
Moisture content	%	Spreadability, dustiness
Bulk density	lbs/cu yd	Indicator of porosity
Water holding capacity	%	Indicator of water supplying capability
Particle size distribution	% passing sieves	Contributes to porosity and WHC

Chemical Properties of Compost

Property	Units	Significance
Total Org C	%	Used to calculate C:N
Volatile solids	%	Indicator of OM
CEC	meq/100g	Cation holding capacity
N – all forms	%, ppm	Total and available N
pH		Indicator of acidity/alkalinity
EC	mmhos/cm	Measure of sol salts
P, K, Ca, etc.	%, ppm	Nutrient availability

Important Compost Properties

Variable	Typical	Preferred
pH	5.0-8.5	6.0-7.5
EC (dS/m)	1.0-10	< 4.0
Organic matter (%)	30-70	> 50
Water holding cap (%)	75-200	> 100
Moisture content (%)	30-70	40-50
Bulk density (lbs/cy)	700-1200	800-1000

Important Compost Properties

Variable	Comments
Nutrients	No minimum; list concentrations
Particle size	1' minus screen
Trace elements	U.S. EPA Part 503 Regulations
Stability	Stable to highly stable
Phytotoxicity	Seed germination & plant growth assays

Assessment of quality is dependent on intended use

Uses of Compost

1. Soil amendment
2. Potting mix
3. Lawn establishment/renovation
4. Mulch

Relative Importance of Quality Attributes for Various Uses

Attribute	Potting media	Land reclamation	Soil amendment for hort crop	Mulch
Plant growth	++	++	++	--
Nutrient cont.	--	+	+	--
pH & sol salts	++	+	+	--
Maturity	++	--	+	--
Particle size	++	--	+	+