Compost specifications for grazing pastures

Introduction

This document is one of a set of six specifications for the application of recycled organics in the following settings:

1. **Horticulture**
2. **Sporting fields and turf production**
3. **Compost blankets for erosion control**
4. **Biofilter establishment**
5. **Pastures**
6. **Landscaping.**

These specifications have incorporated the NSW Resource Recovery Orders (RROs) and Resource Recovery Exemptions (RREs) for compost and pasteurised garden organics which specify legal requirements in NSW under which it is permitted to use these recycled organic wastes on land. The conditions and limits stipulated in these regulations have been included. Note that the resource recovery orders and exemptions (RROs and RREs) only apply in NSW.

The basis of these specifications is Australian Standard AS 4454-2012 Composts, soil conditioners and mulches. This standard specifies the general physical and chemical characteristics of composted products that should be used as a minimum basis for selecting products. These specifications use AS4454 as the basis and recommend additional criteria where it is directly relevant to optimising performance.

These specifications provide guidance on the characteristics of composted recycled organics, and include information on:

- general characteristics and minimum acceptable contamination levels, for the six mentioned applications
- performance characteristics
- appropriate use and application recommendations.

These do not include specifications or details for other recycled organics products such as uncomposted manures, compost made with biosolids or solid or liquid food wastes.*

General Specifications

Many of the criteria listed in AS4454 are relevant to composts for grazing applications, as they specify the basic suitability of compost for land application. These characteristics apply equally to grazing production systems.

Compost specifically for pastures are designed to improve production and increase the health of soils and the pasture species. Healthy pastures provide adequate nutrition to the grazing stock. Healthy pastures are also associated with improved soil condition increased soil coverage, reduced erosion and increased overall productivity.

It is critical that composts applied to grazing pastures do not present risks to stock. Contaminants of all types (biological, chemical or physical) must be at an absolute minimum.

* Composts made with biosolids are managed under the Biosolids Order and have particular conditions that may not be suitable for use under the scope of these brochures.

In addition to these requirements, both generators and consumers of composts must ensure that they are meeting their responsibilities under the Biosecurity Regulation 2017 (clauses 37 and 38). Compost generated from animal material including food waste (such as from kerbside collected food and garden waste), animal manures, rendered products such as blood and bone, abattoir waste, grease trap waste, mixed food organics, and pet food are considered as restricted animal material (RAM[1]) and action under biosecurity legislation applies.

Generators and suppliers of composts that use these feedstocks in compost production must inform consumers. This enables consumers in grazing pasture circumstances to manage the biosecurity risks associated with stock accessing prohibited material.

The general product specifications for composts to be used in pastures are presented in Table 1.

Table 1 General product characteristics for compost used for grazing pastures applications (Source: AS4454)

Characteristic	Unit	Target / typical range	Advice
pH $_{(1:5\ water)}$	pH units	Range 5.5 – 8.0	If >8.0 determine total $CaCO_3$ content
Electrical Conductivity (EC)	dS/m	< 6	High EC may limit application rates
Organic Carbon	% dry matter	15 - 25	Generally higher organic carbon is preferable for composts of equivalent maturity
Carbon: Nitrogen Ratio	(C:N)	Typically 20:1 – 25:1	A higher C:N is generally preferred

Acceptable contamination levels

Composts used in pastures should be as free as possible from all types of contamination. Compost not meeting the limits in Table 2 should be rejected due to possible environmental, animal and human health risks. Most producers will supply a sample of their products if requested.

Table 2 Maximum acceptable level of contaminants for pastures use.

Biological Contamination			
Plant Propagules	Unit	Recommendation	
Viable Plant Propagules	Number	Nil after 21 Days	
Vermicast Sieve Test	% Volume	Nil after 21 days for the fraction ≥ 90% passing the 1.18 mm sieve	
Microbial Contaminant	Unit	AS4454 Limit[2]	RRO Limit[3]
E. coli	MPN/g	-	<100
Salmonella	cfu/g	Absent in 50g	Absent in 25g
Faecal Coliforms	MPN/g	<1,000	<1,000

1 See DPI website **www.dpi.nsw.gov.au/about-us/legislation**
2 As specified in Australian Standard AS4454-2012
3 NSW Compost Resource Recovery Order (RRO) 2016

Physical Contaminants			
Material	Unit	Recommended Limit	AS4454 limit[4]
Glass, Metal and Rigid Plastic > 2mm	% dry matter (dm) (w/w)	≤ 0.25	<0.5
Plastic - light, flexible or film > 5mm	% dm (w/w)	≤ 0.025	<0.05
Stones and Lumps of Clay	% dm (w/w)	≤ 2.5	<5

Chemical Contaminants					
Heavy Metals	Unit	AS4454	Other Chemicals	Unit	AS4454
Arsenic	mg/kg	20	DDT/DDD/DDE	mg/kg	0.5
Cadmium	mg/kg	1	Aldrin	mg/kg	0.02
Boron	mg/kg	100	Dieldrin	mg/kg	0.02
Chromium	mg/kg	100	Chlordane	mg/kg	0.02
Copper	mg/kg	150	Heptachlor	mg/kg	0.02
Lead	mg/kg	100[5]	HCB	mg/kg	0.02
Mercury	mg/kg	1	Lindane	mg/kg	0.02
Nickel	mg/kg	60	BHC	mg/kg	0.02
Selenium	mg/kg	5	PCBs	mg/kg	0.2
Zinc	mg/kg	300			

Performance characteristics

Beyond the quality characteristics specified in AS4454 there are several more characteristics that impact upon compost performance in the field. These performance characteristics differ slightly with each type of application due to production and crop requirements and can also be modified and amended after the composting process to create 'fit-for-purpose' composts suited to specific uses. Table 3 provides recommendations for nutritional characteristics of composts designed for use in pastures.

4 Compost Order 2016 and the Pasteurised Garden Organics (PGO) order both require these limits for rows 1 and 2. PGO Order at: **www.epa.nsw.gov.au**

5 Note that this differs from AS4454 limit of 150mg/kg. Clause 43 of the Biosecurity Regulation 2017 sets 100mg/kg as the maximum allowed concentration for lead (Pb) in a fertiliser. Fertilisers include composts.

Clause 44 of the Biosecurity Regulation 2017 also refers to label requirements on fertilisers that exceed 'trigger levels' for lead, cadmium and mercury of 20, 1 and 0.2mg/kg respectively. The label requirements advise that use of the product may result in the accumulation of those metals in the receiving soils. **legislation.nsw.gov.au**

Table 3 Recommended characteristics for composts designed for use in pastures

Characteristic	Unit	Typical range or desirable level	Advice for pastures
pH (water 1:5)	pH units	5.5 - 8.0	Compost has a natural pH buffering effect due to the high organic matter content. This can counter-balance the acidifying effects of some fertilisers. Conduct soil test results and use higher pH or lime-amended compost for very acid soils and an unamended or lower pH compost for neutral to alkaline soils. This test will guide the choice of compost but is unlikely to be a limiting factor.
Total $CaCO_3$ Equivalent		6.5-7.5 Report only when pH>8	Soils with native mixed pastures are typically slightly acid pH<6. Compost acts as a pH buffer to maintain desired pH. Lime can be added to composts after production and prior to land application to correct an acid soil if required. Soil pH >8 may be found in degraded, weed infested soils. Compost with pH < 7 is best used on soils with pH >8.
Electrical Conductivity (EC)	dS/m	<6	High EC may limit application rates and impact on salt intolerant species such as cocksfoot, white and rose clovers.
Nitrogen (N) - Total	% dry mass	≥1.5% for composts claiming to be providing plant nutrition Typical range: 0.8 - 1.9	About 25-30% of total N in composts is likely to be available in the first year, and about 10% and 5% available in the subsequent 2nd and 3rd years. Therefore, 10 wet tonnes (at 50% moisture) of typical compost can contribute 8 -19 kg N which is approximately equivalent to 15 - 35 kg Urea. The remainder remains unavailable to plants in the long term. In colder climates, these proportions are reduced.
			Composts with higher total N have a greater potential of releasing N over time thus providing a long-term source of N. Typical N requirement for 100-400 kg N/ha /yr.[6] As a guide, compost is unlikely to supply sufficient N, at least during periods of high N demand such as spring establishment and high grazing pressures.
Nitrogen - Ammonium	mg/L in solution	<100 for mature composts Typical range: 10 - 200	Ammonium is a readily plant available form of nitrogen. Mature composts should have low levels of ammonium.
Nitrogen - Nitrate	mg/ kg dry mass	>10 for composts claiming to be providing plant nutrition Typical range: 5-300	Nitrate nitrogen (NO_3) is a readily plant available form of nitrogen. Mature composts should have high levels of nitrate. Generally, composts will not provide sufficient crop N without the compost being amended with additional N by including manures, biosolids or another high N source.

6 Fertilisers for Pastures. NSW DPI 2005.

Characteristic	Unit	Typical range or desirable level	Advice for pastures
Phosphorus (P) – Total	% dry mass	>0.5 for composts claiming to be providing plant nutrition Typical range: 0.1 - 1.1	About 40% of the total P in compost will be available in the first year after application under different climate and soil types. Therefore, at 0.5% P content, 10 wet tonnes of compost (at 50% moisture) would contain 20 kg P. This would provide 8 kg of plant available P and be equivalent to 65 -90kg of super-phosphate. The availability in subsequent years is about 20% in the second year and 10% in the third year of compost application. Compost with low P is desirable in soil with high P reserves (>150mg/kg). P may limit compost application rate, particularly if paddock history includes poultry manure application. Generally, application rates determined to satisfy crop N demands are sufficient to cover P requirements.
Phosphorus (P) – Soluble	mg/L	>200 for compost claiming contribution to plant nutrition Typical range: 15 - 350	Soluble P contributes significantly to plant nutrition and the level is used to calculate compost application rate and nutrient budgeting. Generally, plant requirements for soluble P range from 50 to 75 mg/kg for medium to high production. Levels of soluble P in excess of this may leach from the soil and cause environmental issue in waterways. Compost with higher P needs to be used at lower rates in soil with high P to avoid this.
Potassium (K)	% dry mass	>0.8 for composts claiming to be providing plant nutrition Typical range: 0.5 - 1.0	About 80% of compost applied K will be available in the first year after application and the remaining K will be available in the second year after application. At 0.8% K content, 10 wet tonnes of compost would provide 28kg K. This would be approximately equivalent to 70kg potassium sulphate. Typical K demand in pastures is 30-60kgha.[3] High K levels in composts can limit application rates before the required crop N levels are reached. Guided by crop nutrient demand, it can be useful if the K levels in applied composts are low, to maximise compost use before K supply limits compost application rate.
Sulphate/ Sulphur (S)	% dry mass	Typical level: >0.3	Sulphur is rarely a concern as a deficient nutrient except in sandy soils. Composts generally supply sufficient S to cover plant requirements. Over supply of S is rarely an issue and compost only contain elevated sulphur levels when feedstock contains high amounts.
Sodium	% dry mass	Recommended level: <1	Some composts, in rare occasions, may have elevated levels of salts, particularly sodium chloride (NaCl) depending on feedstock. Lower sodium levels are preferable, particularly in areas with sub-soil salinity. Chloride levels also should be as low as possible. Compost with low chloride should be used on land with sub-soil salinity. Generally, sodium and chloride are not an issue when EC is low (<4 dS/m).
Chloride	mg/ kg dry mass	Recommended level: <600	

Characteristic	Unit	Typical range or desirable level	Advice for pastures
Trace elements[7]			Composts can provide very useful levels of trace elements. These are generally immediately available in composts with neutral pH. Demands for trace elements vary widely with pasture type.
Magnesium (Mg)	% dry mass	Typical range: 0.3- 0.6	Generally, pastures requirements for Mg are 20 mg/kg to produce satisfactory yield. An application of 10 t/ha of compost can provide between 30-60kg/ha Mg more than adequate to meet Mg requirements.
Zinc (Zn)	mg/ kg dry mass	Typical range: 170 - 300	AS4454 limits the amount of Zn in composts to 300 mg/kg. Most composts can supply adequate maintenance levels of Zn but compost Zn alone will not suffice in situations where there is Zn deficiency. Soil Zn should be maintained 14-40 mg/kg to provide adequate Zn for stock.
Boron (B)	mg/ kg dry mass	Typical range: 8 - 26	Composts can contribute to B maintenance but will not supply sufficient o to overcome deficiency. Soil Boron requirements are 5-35 mg/kg. AS4454 limits B concentrations to 100mg/kg. In low rainfall areas with alkaline soils B toxicity may limit compost application to low rates.
Manganese (Mn)	mg/ kg dry mass	Typical range: 350 - 550	Composts can contribute significantly to Mn demands. In acidic, waterlogged soils, toxicity may occur when soil Mn >20 mg/kg.[8] Composts high in Mn need to be used with caution in these soils. Pasture demand ranges 25-300 mg/kg.
Calcium (Ca)	% dry mass	Typical range: 1 - 3.8	At the higher end of the range composts are a good source of Ca. If Ca deficiency is a known problem additional lime blended with the compost will increase both available Ca and pH.
Iron (Fe)	mg/ kg dry mass	Typical range: 8,000-12,000 (0.8-1.2%)	Provided the soil pH is not alkaline, soils generally have abundant levels of iron (around 2.5%) and composts do not significantly add to the availability of Fe, as much of the Fe is associated with organic matter and not readily available. Fe toxicity is rarely an issue except in acid waterlogged soils.
Copper (Cu)	mg/ kg dry mass	Typical range: 40 - 55	Composts can meet Cu demands (7-9 mg/kg)[3] at application rates of 5-10 t/ha and may rectify Cu deficiency. High application (>20t/ha) rates may result in Cu levels beyond plant requirements. Soil Cu levels above 100mg/kg can cause toxicity symptoms in some sensitive crops, particularly in acid soils.
Molybdenum (Mo)	mg/ kg dry mass	Typical range: 1 - 4	The sufficiency range for Mo is 0.15-0.4 mg/kg for a range of pastures. Composts can provide sufficient Mo provided soil pH is neutral to alkaline. Mo becomes unavailable in acid soils.

7 NSW DPI 2005, Fertilisers for Pastures.

8 Soil Sense. NSW Agriculture 2000. (Reference: *Soil Analysis- An Interpretation Manual. Peverill, K.I., L.A. Sparrow and D.J. Reuter, CSIRO 1999*, unless otherwise stated)

Characteristic	Unit	Typical range or desirable level	Advice for pastures
Physical characteristics			
Particle size		70- 80% < 16mm 10- 20% > 25mm	80% < 16mm 20% > 25mm As clay content of soil increases the % of course particles should increase
Stability and Maturity		See Table 4	Pass at least 3 maturity tests (Table 4)

Compost maturity and stability

The maturity and stability of composted products impacts the performance of the product once it is placed on the soil surface or incorporated. If a compost is applied before it is biologically stable and mature the composting process can continue in the field.

The maturity of compost refers to the degree of phytotoxicity. Immature compost will contain more growth-inhibiting compounds that are associated with the early stages of the composting process than mature compost. More mature compost exhibits lower levels of phytotoxicity and a higher degree of stability.

In pastures it is particularly important that compost is properly composted and stable. Immature and unstable compost will deplete the soil of plant nutrients required for the crop.

Table 4 below shows how AS4454 differentiates between composted (immature) and mature compost products using various technical measures of compost maturity:

- composted product must meet three of the criteria with at least one from Group A (Biological Activity) and one from Group B (Plant Growth)
- mature composts must meet four of the criteria with at least two from Group A (Biological Activity) and two from Group B (Plant Growth).

Both composted and mature compost can be used in pastures production.

Table 4 Maturity criteria for composts

Parameter	Composted product	Mature compost
Group A - Biological Stability	Pass at least 1 out 3	Pass at least 2 out of 4
Solvita® Maturity Index	≥ 5 or 6	≥ 7 or 8
Nitrogen Drawdown Index (NDI)	>0.2	> 0.5
Specific oxygen uptake rate (mg O_2/g BVS/hr) at 30°C	< 3	≤ 1
Carbon dioxide respiration (mg CO_2/g BVS/day) at 30°C	≤ 12	≤ 8
Dewar self-heating (°C)	≤ 20°C	≤ 10°C
Group B - Plant Growth Tests	Pass at least 1 out of 3	Pass at least 2 out of 4
Ammonium N (mg/kg)	< 200	< 100

Parameter		Composted product	Mature compost
Plant growth test (Bioassay)	Root length (mm)	> 60mm	N/A
	In-vitro germination and root elongation (% of control)	> 80%	> 90%
	Seedling emergence (% of control)	Emergence >80%, Vigour >85%	Emergence > 90%, Vigour > 95%
Ammonium to Nitrate ratio		< 3.0	< 0.5
Volatile Fatty Acids (moles/g dry mass)		< 1,000	< 200
NH_3 volatile ammonia (gas) (ppm/4-hour test)		< 800 (≥ Solvita® 4)	< 100 (≥ Solvita® 5)

Use

To obtain consistent and optimal benefits, recommendations for use include:

- Incorporate into soil or surface apply at the beginning of the pasture replenishment or establishment cycle.
- Surface application prior to spring demand.
- Apply after grazing to rapidly growing pastures.
- Obtain a soil test and use as a guide for application rates; e.g. apply at higher rates if SOC/SOM is low.
- Application rates of 5-10 wet tonnes/ha annually with repeated application over several years.
- Compost application between 3-5 tonne/ha have been shown to reduce presence of weak competitor weeds such as African Love grass. Action is by promotion of strong pasture growth.

Composts are particularly useful on soils:

- that are deficient in a range of trace nutrients
- have low CEC and organics matter
- have a long history of hay or silage removal
- that are recently cleared or prepared for pasture improvement
- that are light, sandy and low in organic matter.

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Disclaimer

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Glossary

Terminology	Definition
AS 4454	Australian Standard 4454-2012: *Composts, soil conditioners and mulches*
EC	Electrical conductivity
NSW EPA	New South Wales Environment Protection Authority
RO	Recycled organics
RRE	Resource recovery exemption
RRO	Resource recovery order

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