Developing Product Specifications for Your Compost:

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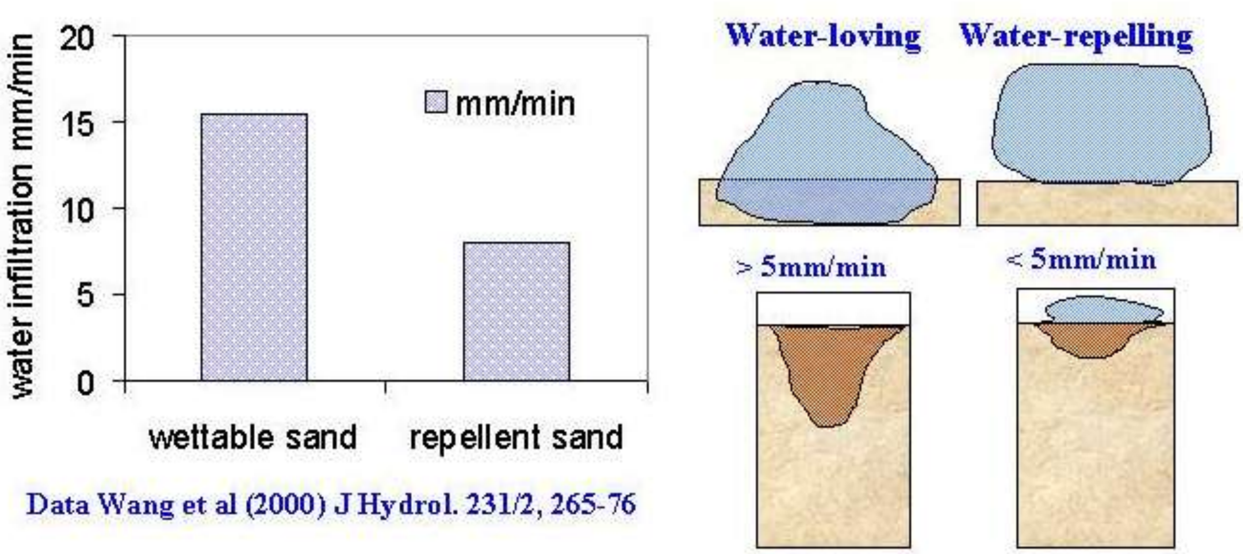
Can do Sheet **No. 20**

For a composted product to be truly 'fit for purpose', the physical, biological and chemical properties of the compost must be matched with the proposed end-use. An objective product specification sets the benchmark for in-house quality control, and is essential for targeting the best market for your product.

Identifying Potential Hazards in Compost, and Strategies for Control

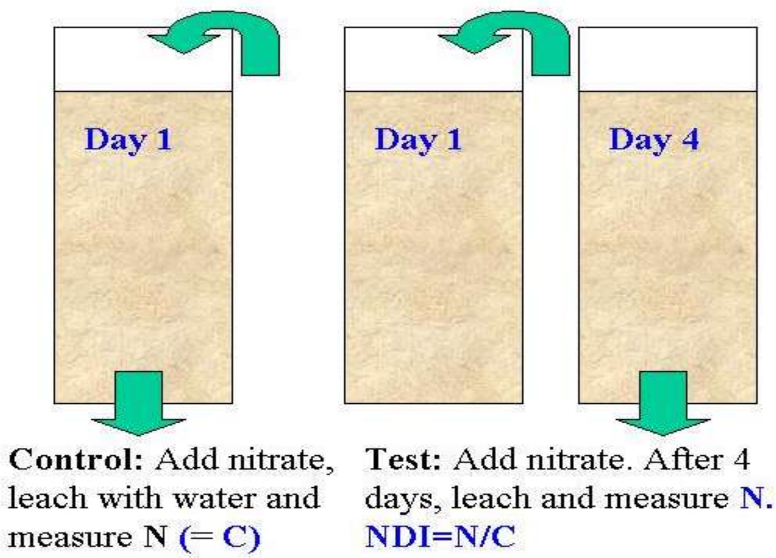
Composted products may have many different end-uses, depending on the size and relative proportions of particles (eg a mulch, fine mulch, soil conditioner or top-dressing, refer 'Can Do' Sheet 19 **Determining the Soil Conditioning Properties of your Compost**), the maturity or biological stability (eg biofilter media, bioremediation, erosion control, mulch or soil conditioner), and the concentration of plant nutrients that it contains (eg component of a potting medium or a landscape soil, a mulch, a fertilizing compost, a soil conditioner or a top-dressing). However, depending on the raw materials used and the conditions of composting, the product may be hazardous for some end-uses. For example, if the intended use was as a surface mulch, and the raw materials contained more than 20% of fine (<10 mm), waxy particles, applying the material after less than 6 weeks thermophilic composting may induce water repellence. This is a **Hazard**, as less water drains into the soil (Refer to the graph below), causing plants to dehydrate. The strategy to control this is to compost for at least 6 weeks to degrade all of the plant waxes, and to use the **Wettability test** (Refer to the diagram below) to prove that your product is fit for purpose.

Figure 1: The impact of water-repellent material preventing water from draining into soil or potting mix (the **Hazard,** refer to the graph), and the **Wettability test** (refer to the figure) to ensure your product is not water-repellent. The dry, sieved compost sample is placed in a cylinder and10 mL of water is added to a slight depression. Uncomposted plant waxes stop water droplets from contacting the soil, preventing water infiltration. If the 10 mL of water has not drained within 5 minutes (the **benchmark** for **Control**), the compost is not 'fit for purpose'. Plants grown in waater-repellent media dehydrate and die after the mix dries out, and fails to re-wet.



Plant waxes should be degraded during the **active phase** of composting (refer 'Can Do' sheet 4, **On-Farm Co-Composting**). However, if the windrow lacks the moisture and air-filled drainage pores for microbial growth, these water-repellent waxes will remain. This is not necessarily a problem for mulch and fine mulch that have low levels of fine (<10 mm) particles, as repelled water will roll between the larger particles onto the soil surface. Mulches are subject to fewer potential hazards than soil conditioning composts, provided they do not contain too many physical and chemical contaminants, and provided the level of salts is less than 1.2 dS/m (refer 'Can Do' sheet 19 for the test methods and recommended benchmarks). The particle size range in a mulch is too large for microbes to use, and if made from greenwaste, straw or woodchip, the quantity of plant nutrients and potentially **hazardous salts** will be low. Over time larger soil animals will break the mulch down, but this will take months to years, so the **hazard** of releasing large quantities of nutrients at the one time is very low.

Uncontrolled nutrient release is a problem for plants and the environment. Some nutrients act as salts, burning sensitive leaves and roots. Other beneficial plant nutrients such as phosphorus and nitrogen must be applied in the right amounts to maintain healthy plants, Too much N or P may interfere with normal plant functions, making the plant susceptible to root diseases. Too much applied at a time when plants cannot use it all, may flow into surface and groundwater, increasing the environmental **hazards** of algal blooms and nitrate poisoning.



A mulch **conditions the soil** by protecting the surface, conserving topsoil and water (refer 'Can Do' sheet 14 **When is a Compost a Mulch**). The burrowing activity of the soil animals in the mulch also **conditions the soil** by increasing the proportion of fine pores available for aeration and drainage. Earthworms are the best known soil animals, but soil insects such as ants, termites, grubs and millipedes may be far more active, particularly during dry times of the year (refer to 'Can Do' sheet 3, **What is a Healthy Soil**). The relatively hostile nature of the soil surface, and the large diameter and woody nature of the particles ensures the mulch will last for months to years, before the soil animals break the particles into the smaller pieces that microbes are capable of recycling (the fermentation layer in **Figure 1).**

Mulch is applied at **depths of 50 to 100 mm**, at rates of up to **50 L per square metre**. At these high rates, it is important that the mulch does not contain high concentrations of plant-available nutrients such as potassium and phosphorus. It is also important that the water used to compost the mulch is not too salty. The tests in **Table 1** are designed to ensure a mulch will not harm plants if applied at a high rate.

Characteristic and unit of measurement	Pasteurised Mulch	Pasteurised Fine Mulch	Purpose for Product Specification
Duration of Composting	Core temperature 50-70 ^{0} C for 3 to 6 weeks, with at least x5 turns	Core temperature 50-70 ^{0} C for 6 weeks, with at least x5 turns	Hazard is survival of pathogens,
pH pH units	5.0 – 8.0	5.0 – 8.0	1:1.5 leachate as per AS3743
Electrical Conductivity dS/m	< 2 dS/m	< 2 dS/m	1:1.5 leachate as per AS3743
Phosphorus, soluble mg/L in solution	<10 mg/L or <3 mg/L for P-sensitive plants	<10 mg/L or <3 mg/L for P-sensitive plants	As per AS4419 for P-sensitive spp)
Ammonium N mg/L in solution	$\leq$ 200 mg/L	$\leq$ 200 mg/L	As per AS4419 for organic soils
Particle size grading using a 16 mm and for fine mulches a 10 mm sieve % mass	Equal to or more than 70% by mass in the shortest dimension to be retained by the sieve	More than 20% but less than 70% larger than 16 mm, with not more than 20% of the particles smaller than 10 mm.	Fine mulch with greater than 20% of particles less than 10 mm may cause nutrient drawdown (N and P) if not composted into the curing phase.
Wettability Minutes	Not applicable	<5 minutes for the < 5 mm particle size	Use <5 mm particles to avoid bridging particles, and method as per AS3743
Chemical contaminants	Must not exceed the limits	Must not exceed the limits	As per AS4454 Municipal green-waste may contain heavy metals that may harm beneficial soil microbes
Physical contaminants	Must not exceed the limits	Must not exceed the limits	As per AS 4454 Glass or metal sharps in mulch cannot be tolerated in root vegetable production soils.

Table 1: Test methods and limits to ensure that a **mulch** will not harm plants, or pose a risk to waterways. High temperature composting for the minimum period guarantees the hygiene of the mulch. AS refers to the Australian Standard most relevant for undertaking and interpreting the specified test. Use this list when engaging a commercial laboratory to test your mulch. Most on-farm mulches should not contain physical or chemical contaminants. However, checking mulch for chemical contaminants such as heavy metals and persistent pesticides at least once a year is a good idea, to avoid unintentionally contaminating your soil.

Determining the Properties of a Soil Conditioning Compost

By definition, a soil conditioning compost is produced from much finer, microbially reactive organic particles (less than 20% larger than 16 mm, AS4454). The smaller the organic particle, the greater the surface area exposed for microbes to degrade, per unit volume. However, decomposition will only occur if the windrow is managed to provide the 'wet and well aired' conditions that are essential for microbial activity (refer **'Can Do' sheet 4: On-Farm Co-Composting**).

During the **active phase** microbes take in luxury amounts of nitrogen (N) and phosphorus (P), but most of the potassium (K) remains in the plant-available form. At the end of the **active phase**, when only tough organic carbon is left, the microbes start to release P in the plant-available form (fertiliser equivalence). During the **curing phase,** microbial activity stabilizes to a lower level. The heat declines below 50 ^{0}C and the proportion of N, P and K in the plant-available (fertilizer equivalent) form stabilizes. Microbes process the remaining carbon into humus-like organic matter, increasing the nutrient-holding capacity (Cation Exchange Capacity shown in **Table 2**) and the water-holding capacity of the compost.

Cured, fine compost type	**Fertiliser** and **slow-release N** kg/t	**Fertiliser** and **slow-release P** kg/t	**Fertiliser** and **slow-release K** kg/t	**Organic Carbon** kg/t and **Cation Exch. Capacity**
Cotton Trash	0.5	1.1	11.0	208
	24.2	**2.0**	**2.3**	**80**
Feedlot Manure	0.1	2.2	17.6	223
and Sawdust	**30.0**	**13.5**	**4.4**	**120**
Sugar Milling	0.1	4.6	2.5	160
Byproducts	**8.9**	**6.4**	**na**	**53**
Green Waste	0.3	0.3	4.5	272
(not cured)	**9.0**	**1.5**	**na**	**20**

Table 2: Results for the fertilizer equivalence and soil conditioning properties of cured, soil conditioning composts produced from different raw inputs. The testing methods used to produce these results are listed in Table 3. During the composting process, the nutrients become concentrated and the proportion of nutrients in the plant-available and slow-release organic form change. The water and nutrient-holding capacity of the compost depend on the humification of the organic carbon present in the compost, a process that only occurs during the curing phase. For these reasons, **only cured composts** should be tested for their fertiliser equivalence and soil-conditioning properties.

The data in **Table 2** indicates how the fertilizer and slow-release concentrations of the major plant nutrients N, P and K differ in cured composts produced from different organic inputs. These results are essential to calculate appropriate application rates for high-nutrient, soil conditioning compost. For example, if the feedlot manure compost was applied at too high a rate, the high fertilizer potassium content could burn plant roots. The feedlot compost should be applied as a **replacement** for all potassium fertilizer.

Table 3 on page 4 lists the tests you need done on your cured soil conditioning compost to be able to calculate an appropriate application rate and to adjust conventional fertilizer rates to maintain a balanced plant nutrient regime. Anecdotal evidence from Queensland indicates the slow-release of P from cured composts starts shortly after soil application. However, **slow-release N** does not begin until about a year later. Use soil tests prior to planting subsequent crops, to cut back on conventional N and P fertiliser.

Soil Conditioning Composts can only improve soil health if the plant-available and the slow-release nutrients they contain are included in a balanced fertiliser management regime.

Property and Units	Cured Soil Conditioner	Test method
Duration of Composting	12 to 18 weeks with core at 50 to 70 degrees C, and a minimum of x5 turns	Record temperature profile in windrow to verify compost has entered the curing phase (refer 'Can Do' Sheet 4, On-Farm Co-Composting)
pH pH units	5.0 – 8.0	Test < 2 mm particles as a 1:5 soil solution (R&H 4A1)
Electrical Conductivity dS/m	< 1.2 dS/m If > 1.2 dS/m, Exchangeable Sodium Percentage < 15%	Test < 2 mm particles as a 1:5 soil solution on 'as received' moisture, do not dry (R&H 3A1).
Effective Cation Exchange Capacity mEq/100 g	Exchangeable sodium percentage < 15% Use results for K and Ca to calculate fertilizer equivalence of the compost as mg/kg	Method R&H 15A1 if EC <1.2 dS, R&H 15B2 if EC $\geq$ 1.2 dS. Use results to calculate exchangeable sodium percentage, and exchangeable potassium K) and calcium (Ca) fertilizer equivalence.
Phosphorus, soluble mg/kg dry mass basis	Use mg/kg for calculating phosphorus (P) fertilizer equivalence of the compost. Reduce inorganic fertilizer to allow for the P in the compost.	Method R&H 9C The concentration of soluble P or exchangeable K will set the upper limit for the rate of compost application, replacing conventional inorganic fertilizer.
Phosphorus total mg/kg dry mass basis	Subtract soluble P value from total P to indicate organic 'slow release' P in the compost.	Method R&H 9A Use soil tests to reduce fertilizer P application in subsequent crops
Ammonium N mg/kg dry mass	< 100 mg/kg.	Method R&H 7C1a Cured compost should not contain ammonium.
Nitrate and Total N mg/kg dry mass basis	Use soil tests to reduce fertilizer N in subsequent crops, to allow for the slow-release (organic) N contained in the compost.	Method R&H 7C and 7A Nitrate in cured compost is low. Composts with high organic N could downgrade fruit quality of subsequent crops if the slow-release N is not included in the fertilizer management program
Nitrogen Drawdown Index	>0.5 (preferably >0.7) Compost with a low NDI will starve plants of fertiliser N & P	As per AS3743, on particles < 10 mm. If the compost contains high ammonium or nitrate N, the test result for NDI is invalid.
% Organic Carbon	The humus-like organic carbon improves the nutrient and water-holding capacity of the soil.	Method R&H wet oxidation (preferably >11% of the oven-dry mass of the compost) or furnace induction (preferably >15%)
Bulk Density dry mass basis kg/m^3	Required to convert a mass based application to a volumetric rate.	As per AS4419
Moisture content %	25 to 45% depending on the size of the compost particles	As per AS4454 Required to adjust the fertiliser equivalent of the compost from oven-dry weight to field weight.
Chemical contaminants	Must not exceed the limits	As per AS4454 Municipal green-waste, old chicken and piggery manure may contain heavy metals that may harm beneficial soil microbes

Table 3: Methods to determine the fertilizer equivalence and soil conditioning properties of a cured compost. Historically, some animal manures may be contaminated with heavy metals such as cadmium, arsenic or copper. Testing avoids unintentionally contaminating soil. R&H refers to Rayment & Lyons (2011) Aus. Lab. Handbook of Soil and Water Chemical Methods.

Sheet updated 11/2011