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Preparing compost from aquatic weeds removed from waterways

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Summary

This Primefact outlines the factors that need to be taken into account if you plan to compost aquatic weeds removed from waterways.

Composting effectively reduces the viability of the weeds and allows for the safe re-use of the nutrients and organic matter contained in the weed material.

However, it is important to manage the composting process in accordance with the requirements of the Australian Standard for compost, soil conditioners and mulches (AS4454; Standards Australia 2003) to minimise the risk of weeds surviving. Of particular concern is alligator weed which can grow in soil and water.

Likewise, compost quality can vary from site to site, so it is important to test individual batches of compost using the criteria defined by AS4454. Understanding the properties of the compost will help to maximise the benefits from using it, as well as minimise potential risks associated with heavy metals, chemical residues and other compounds that may cause damage to plants.

Introduction

Aquatic plants used as ornamental plants in aquariums and fish ponds often escape into the surrounding environment where they have a devastating effect on water quality. They can bring rivers and lakes to a standstill and destroy the livelihoods of communities that depend on them. Three significant aquatic weeds in the Hawkesbury–Nepean River and other NSW coastal waterways are salvinia, *Egeria densa* and alligator weed.

In 2004, NSW DPI removed 70,000 m^3 of aquatic weeds in the Hawkesbury River to control a large infestation of salvinia (*Salvinia molesta*). The removed material also included alligator weed and *Egeria densa*. Salvinia and *Egeria densa* rapidly dry out after removal from the river to form a loose and lightweight organic material, but alligator weed can continue to grow in residual moisture.

The preferred option for managing the removed material was to compost it and potentially use the end product on degraded land to increase ground cover, promote revegetation and reduce runoff and soil erosion. Consequently, the Department of Environment and Conservation (NSW) funded NSW DPI to undertake research to assess potential environmental risks associated with the compost and its usefulness for improving land condition in the Hawkesbury–Nepean Catchment. This Primefact describes the outcomes from the risk assessment component of the project.

Composting process

While this Primefact focuses on the composting of salvinia, alligator weed and *Egeria densa*, the principles and processes are applicable to the composting of other aquatic and terrestrial weeds.

Composting site

The composting site must have a compacted base (hardstand). The site should be free of weeds, and able to capture surface runoff and any leachate draining through the soil.

State and local government planning and environmental approvals might be required to establish a composting site, so you need to consult the Department of Planning, the Department of Environment and Conservation (NSW) and your local council before starting any composting.

Material density

Salvinia and *Egeria densa* rapidly decompose to form a loose and lightweight organic material (Figure 1) that is too light to compost well. To be dense enough for composting, it needs to be blended with other materials, such as leaves, grass clippings and woody prunings.

Figure 1. Once removed, salvinia and *Egeria densa* dry rapidly to form a loose and lightweight organic material, but alligator weed may continue to grow in the residual moisture.

Windrows

After the weeds are blended with the other materials, arrange them in open windrows on compacted hardstands. A suggested size for the windrows is 2.5 to 4 m wide, 1.5 to 2 m high, and 75 to 100 m long.

Composting stages

Composting has four stages:

1. Mesophilic phase: 20º–45ºC, organic materials begin to decompose.

2. Thermophilic phase: > 45ºC, respiration and windrow temperature increase. Temperatures > 55ºC are required to destroy weeds, weed seeds and plant, animal and human pathogens (Keen *et al*. 2002).

3. Cooling and curing phase: occurs when readily available organic carbon is depleted.

4. Maturation phase: ensures the compost is stable and does not reheat.

Compost turning

Temperatures vary throughout the windrow (Tee *et al.* 1999), so turning and mixing is necessary to ensure that all the material is exposed to the high temperatures. The Australian Standard for composted soil conditioners and mulches (AS4454) states that 'the minimum requirement for achieving pasteurisation is the appropriate turning of the outer material to the inside of the windrow so that the whole mass is subjected to a minimum of three turns with the internal temperature reaching a minimum of 55°C for three consecutive days before each turn' (Standards Australia 2003).

Composting time

Generally the composting process takes 12–16 weeks from initiation to maturation and includes 4–5 turns, 1–2 weeks apart, and curing time. A front-end loader or a purpose-built straddle turner (Figure 2) is used to turn the compost windrows.

Microbial activity will be reduced and temperatures will be lower on the surface of the windrow during the winter months. However, the composting process should not be overly affected by the time of year as the core temperature in the windrow should remain high.

Figure 2. Straddle turner used to turn compost windrows.

Compost screening

After the compost has matured it is screened to different grades to suit the end use of the product. Soil conditioners and coarse mulches are typically screened to <10 mm and >15 mm, respectively.

Site monitoring and evaluation

Salvinia and *Egeria densa* are killed by drying out and stockpiling on land, so the likelihood of them surviving the composting process is very low. However, alligator weed grows easily in soil and water and could infest riparian and terrestrial land where the compost is applied. Therefore, it is important to ensure that any alligator weed and other soil-based weeds in the compost do not survive the composting process.

Weed mortality depends on the temperature within the composting windrows and the length of time the material is subjected to the composting process. Hence, it is vital to monitor windrow temperatures to ensure the correct conditions are achieved.

Monitoring windrow temperatures

Stainless steel digital temperature probes can be used to monitor temperatures in the top, middle and bottom of the windrow during each phase of the composting process (Figure 3).

Temperatures need to be measured several times a week between turns to determine whether the thermophilic (> 45ºC) and pasteurising temperatures (> 55ºC) required for killing weeds and pathogens are reached. Several measurements need to be taken randomly in each windrow, to ensure the results reflect conditions throughout the windrow.

It is useful to plot the temperatures in the windrows over time (as shown in Figure 4) to demonstrate the windrow has gone through the four composting stages.

Site monitoring

Check the site regularly for any weeds growing in or around the compost windrows (Figure 5). Remove weeds manually or with an appropriate herbicide. If you find weeds, review your composting procedures to identify the cause of the outbreaks and take action to prevent them occurring again.

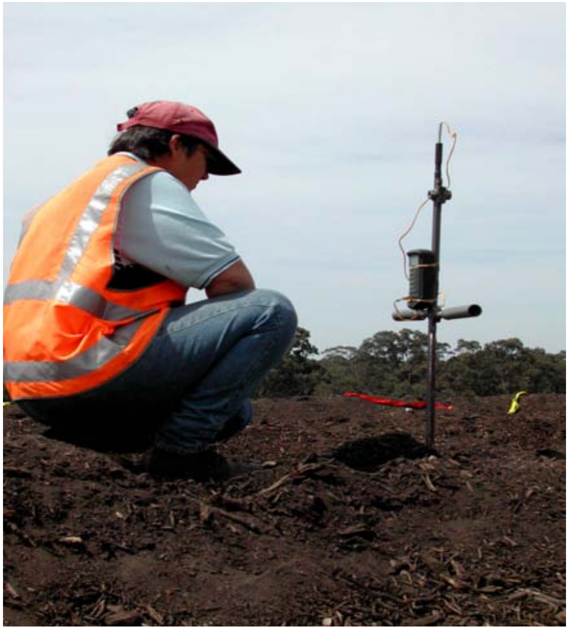

Figure 3. Digital temperature probes determine whether the compost is reaching temperatures required for killing weeds and pathogens.

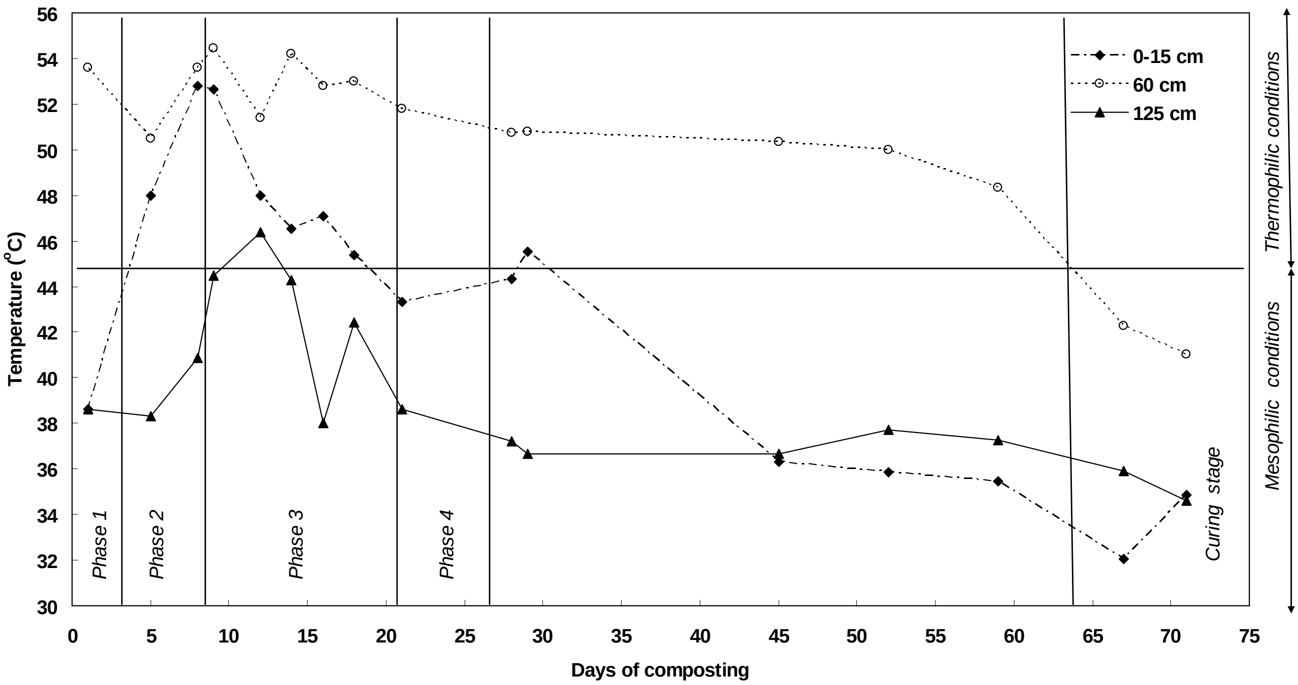

Figure 4. This graph shows how the temperature of the compost changes over time (1/9/2005 – 6/12/2005), and how the temperature differs in different levels of the windrow. It is important to turn the windrow regularly so that all of the material is exposed to the high temperatures in the centre of the windrow (~60cm) to ensure all weeds and pathogens are destroyed (Adapted from Dorahy *et al* 2006).

Figure 5. Monitor the windrows regularly for weeds growing in or around the compost. Remove any weeds found and review site processes and controls to prevent further outbreaks.

Compost quality

Once the composting process is completed, you need to test the compost for nutrient levels and contaminants such as heavy metals and pesticides. Compost quality can vary from batch to batch and site to site. It is influenced by a number of factors including the source and type of blending material and feedstock used for manufacturing compost. Therefore each batch of compost needs to have its physical, chemical and biological properties tested. To do this you need to send samples of the compost to accredited labs for analysis.

Sampling and analysis

Due to differences in methods of compost production, there is no universal sampling procedure, but make sure your process includes the following principles.

1. Use sampling equipment and containers that prevent contamination i.e. stainless steel sampling devices and borosilicate sample containers with screw top lids.
2. Divide the total compost into batches of no more than 100 tonnes and take at least one random sample from each batch.
3. Standardise your sampling technique so that it is constant within and between batches.
4. Make sure samples are representative of the compost.
5. Take at least five sub-samples to make up a composite sample.
6. Have the same number of sub-samples in each batch.
7. Mix batch sub-samples thoroughly to make a composite sample for analysis. A composite sample allows the characteristics of a batch to be more accurately estimated.
8. Analyse the samples for the properties listed in the Australian Standard for composts, mulches and soil conditioners (AS4454) and compare the results against the physical, chemical and biological limits set by those standards.

The authors of this Primefact can be contacted for up to date advice on laboratories accredited to test composted products in accordance with Standards Australia (2003).

Compost analysis

The chemical and biological data provided by analysis provides important information about compost maturity and the likelihood of it causing damage to plants, either through ammonium toxicity or the presence of other toxic elements.

Analysis of the compost prepared from aquatic weed physically removed from the Hawkesbury River (Table 1) shows that the compost was slightly alkaline (pH of 7.2) and moderately saline (electrical conductivity 2.2 dS/m). These results are comparable to composts prepared from source-separated garden organics. However, the compost had low levels of nitrogen, phosphorus and calcium.

Removal and stockpiling operations may introduce inorganic material such as sand and sediments into the material which may reduce the proportion of organic matter in the final compost product. In this instance, the aquatic weed compost only contained 19.6% organic matter, which is less than the 25% minimum prescribed by Standards Australia (2003). Because 95% of particles were less than 15 mm diameter, this compost would be classified as a soil conditioner. The high proportion of nitrate to ammonium (38:1) and a toxicity index of more than 60 mm suggest the material is unlikely to be toxic to plants.

It is also important to consider the likelihood of contaminants such as heavy metals and chemicals occurring in the final product, as this could restrict its end use. In this instance, the heavy metal concentrations (Table 3) and chemical residues in the compost were all less than the Grade A limits defined by NSW EPA (1997).

The results from the lab analyses help you to assess the compost’s likely benefits and potential risks for soil application. In this case, the low level of contaminants indicates the compost would be safe for use as a soil conditioner, particularly in areas of catchments denuded of topsoil.

Table 1. Chemical properties of compost prepared from aquatic weeds physically removed from the Hawkesbury–Nepean River compared with the Australian Standard for composts (AS4454).

Chemical Property	Average	AS4454
pH	7.2	5.0–7.5[A]
Electrical conductivity (dS/m)	2.2	No limit
Soluble phosphorus (mg/L)	0.4	≤ 5[B]
Ammonium (mg/L)[#]	0.7	< 200
Nitrate (mg/L)[#]	26.4	≥ 10[C]
Ammonium + nitrate (mg/L)[#]	26.6	> 200[C]
[§]Organic matter (%)	19.6	≥ 25
Nitrogen (%)	0.6	≥ 0.6[C]
Phosphorus (%)	0.1	≤ 0.1[B]
Calcium (%)	0.6	–
Magnesium (%)	0.2	–
Sodium (%)	0.1	< 1[D]
Boron (mg/kg)	0.1	< 200[E]

[A] If pH>7.5 determine total $CaCO_3$ content; [B] for products which claim to be for P sensitive plants; [C] if a contribution to plant nutrition is claimed. No requirement for composted mulches; [D] or at least 7.5 moles Ca plus Mg for each mole of Na in the dry matter. [E] Products with total B <100 can have unrestricted use. [§]Dry matter basis. [#]water soluble N.

Applying compost to land

Applying composted soil conditioners and mulches to land has many benefits. The organic matter and nutrients in soil conditioners can increase soil fertility, provide a benefit to plant nutrition and promote revegetation. Mulches provide surface cover, reduce runoff and erosion (Wong *et al.*, 2005) and conserve soil moisture. However compost performance depends on the compost's characteristics and these can vary, which highlights the importance of testing. NSW DPI is currently preparing guidelines for using composts in catchment rehabilitation works.

Table 2. Physical and biological properties of compost prepared from aquatic weeds physically removed from the Hawkesbury–Nepean River compared with the Australian Standard (AS4454).

Property	Average	AS4454
Moisture (%)	25	> 25
Wettability (minutes)	6.6	< 7
Particles <16 mm (%)	95	> 20[§]
Particles >16 mm (%)	5	20–70[‡]
Rigid contaminants[#] (%)	0.2	≤ 0.5
Light plastics***** (%)	0.04	≤ 0.05
Stones & clay****** (%)	6.8	< 5
Toxicity Index (mm)	97	≥ 60

[§]Soil conditioner; [‡]Fine mulch; [#]Glass, metal and rigid plastics (>2 mm); *****Light plastic > 5 mm; ******Stones and lumps of clay >5 mm.

Table 3. Heavy metal concentrations in compost prepared from aquatic weed physically removed from the Hawkesbury River compared with the limits defined by NSW EPA (1997).

Heavy metal	Average (mg/kg)	Grade A limit
Arsenic	9.1	< 20
Cadmium	< 1.0	< 3
Chromium	18	< 100
Copper	27	< 100
Lead	63	< 150
Mercury	< 0.1	< 1
Nickel	9	< 60
Selenium	< 3.0	< 5
Zinc	198	< 200

Conclusions

The main environmental risk in using aquatic weed compost is the potential for weeds to survive the composting process, particularly alligator weed, which can survive in soil and water. However, the risk is significantly reduced if the Australian standard for producing composted soil conditioners and mulches (AS4454; Standards Australia 2003) is followed. This includes:

1. ensuring the compost is adequately mixed and turned during each composting phase;
2. adding feedstock, such as source-separated garden organics, to increase windrow temperatures to complete thermophilic decomposition (> 45°C) and pasteurisation (> 55°C);
3. completely turning the compost windrows at least 4–5 times during the composting cycle;
4. using temperature probes to ensure required temperatures are achieved;
5. monitoring the windrows and surrounding area for alligator weed and other weeds;
6. removing any weeds by hand or spraying.

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