WHEN IS A COMPOST A MULCH?

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Can do Sheet No. 14

A mulch is a cover applied to the soil surface to modify the impact of climate on soil processes. Thermophilic composting can improve the mulching properties of organic materials. However, due to the high application rates required, nutrient budgeting must be undertaken to maintain soil health.

Why Mulch the Soil?

Plastic mulches have been used in high value horticulture to enhance the action of soil fumigants, to suppress weed growth, to repel insects from attacking crops, and to reduce water loss from the soil. However, reviving the traditional use of organic materials as a mulch (eg for **straw**berry production), can improve **soil health** by:

- buffering the soil from temperature extremes,
- reducing the risk of erosion whilst promoting seed germination (**hydromulching**)
- promoting air exchange whilst reducing evaporative water loss (eg **Figure 1**)
- providing a habitat and a food resource for burrowing soil animals (refer **Can Do sheet 3** on What is a Healthy Soil).

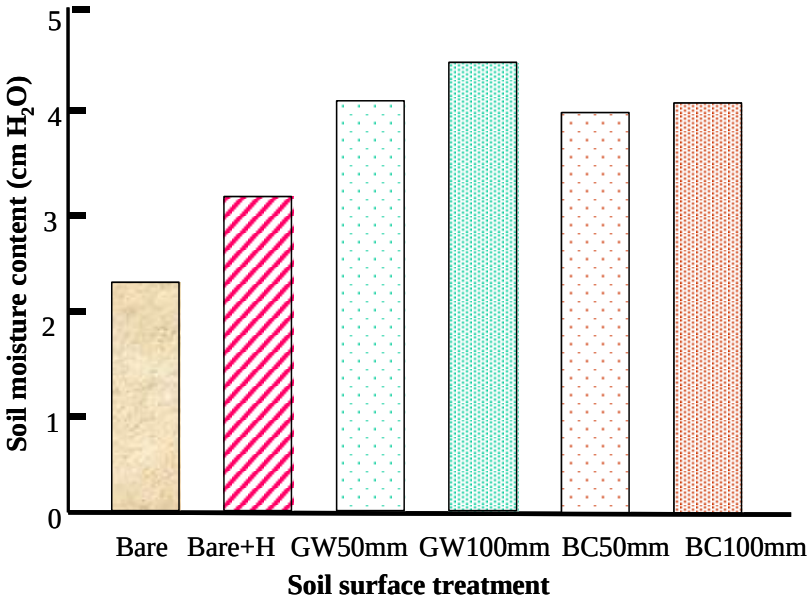

Figure 1: The effect of different treatments on the conservation of soil moisture. Bare ground was maintained by either hand removal of weeds (Bare), or use of a herbicide (Bare+H). Green waste (GW) or bark chip (BC) was applied at depths of 50 or 100mm. Source of the data was Pickering et *al*. (1998) The suitability of composted green waste as an organic mulch. *Acta Horticulturae* 469: 319-24

Nitrogen-fixing legumes such as clovers, vetches and pinto peanut have been used as **living mulches** in orchards and for some vigorous field crops such as corn. However, in some field trials in Australia, using the wrong organic materials as a mulch has resulted in severe leaf yellowing in citrus, seedling emergence failure in two consecutive cotton crops, and the elimination of earthworms from under vines.

Desirable Attributes of an Organic Mulch

To function as a mulch, a relatively thick layer of material needs to be applied to the soil surface. The Australian Standard for Composts, Soil Conditioners and Mulches (AS 4454 2003) indicates a low application of mulch would be about 4 L per m^2, with a high rate of 50 L per m^2. To maintain soil health at these high application rates, organic materials must meet the following criteria:

- The mulch should be free of plant propagules and plant pathogens, to avoid contaminating farms with plant diseases and weeds (**pasteurizin**g mulch by composting above 55^0C for a minimum of 3 to 6 weeks with at least 5 turns kills these)
- The individual particle size should be large (AS 4454 specifies **>16mm**), to improve persistence (months to years), aeration and drainage
- The presence of natural plant toxins should be low enough to enable sown crops to germinate and to encourage the activity of soil animals and microbes (**pasteurizing** breaks down both plant toxins and waxes)
- The presence of natural plant waxes should be low enough to enable the mulch to wet up after drying out (AS 3743 2003 specifies a wettability benchmark)
- The organic carbon component of very fine particles (<10 mm, a **Fine Mulch**) should be **biologically stable**, to ensure that after application, nutrient drawdown does not starve plants of nitrogen and/or phosphorus (AS 3743 2003 specifies a Nitrogen drawdown benchmark)
- The presence of **burning salts** such as sodium, chloride and potassium should be low enough to enable sown crops to germinate and to encourage the activity of soil animals and microbes (AS 3743 2003 specifies an electrical conductivity benchmark)

How Thermophilic Composting Improves the Properties of a Mulch

Thermophilic (high temperature) composting encourages the activity of a diverse population of microbes to break down waxes, natural plant toxins and simple organic carbon compounds present in organic residues. Microbial activity elevates the temperature within the windrow to above 50^o C, provided water, aeration and simple carbon compounds are not limiting (refer **Can Do sheet 4** on Co-Composting). The combination of high temperature and humidity destroys most plant and pathogen propagules and chemicals (including pesticides), provided the compost is turned to ensure that all of the material passes through the heated core of the windrow.

The composting process also stabilizes the biological activity within fine (<10 mm) organic material by effectively removing all the simple organic compounds ('carbohydrate' energy converted by microbes to the gas carbon dioxide). To achieve all of the desirable outcomes listed above, composting would need to continue for **at least 6 weeks**. Windrows containing waxy plant materials such as cotton trash or timber byproducts with a high concentration of natural toxins do not readily heat up until the waxes and toxins have been destroyed. At least a fortnight for this **consolidation phase**, and **at least five turns** during the elevated temperature phase (>55^0 C) over 4 weeks is needed to pasteurize the mulch and to destroy waxes and plant chemicals.

The duration of 6 weeks meets the definition of a composted product in AS4454 2003. However, not all organic materials will have reached the point of **biological stability** within 6 weeks of composting. This can be a major problem for **fine mulches** (containing nutrient-rich particles less than 10 mm in diameter), due to the risk of **nutrient drawdown** and **oxygen starvation** occurring after high-rate application to the soil surface.

Why Limiting Particle Size is Essential for a Mulch

Per hectare, at the low 4L/m^2 mulch application rate a total volume of 40m^3 is required (AS 4454 2003). For the cotton trash compost in **Figure 2** this equates to 6t/ha. At the higher mulch application rate of 50L/m^2, per ha 500m^3 is required, equating to 75t/ha of the cotton trash compost. These high application rates may substantially alter the biological processes occurring within the soil surface layer if fine (<10 mm particles), nutrient-rich organics such as the cotton trash compost are used as a mulch.

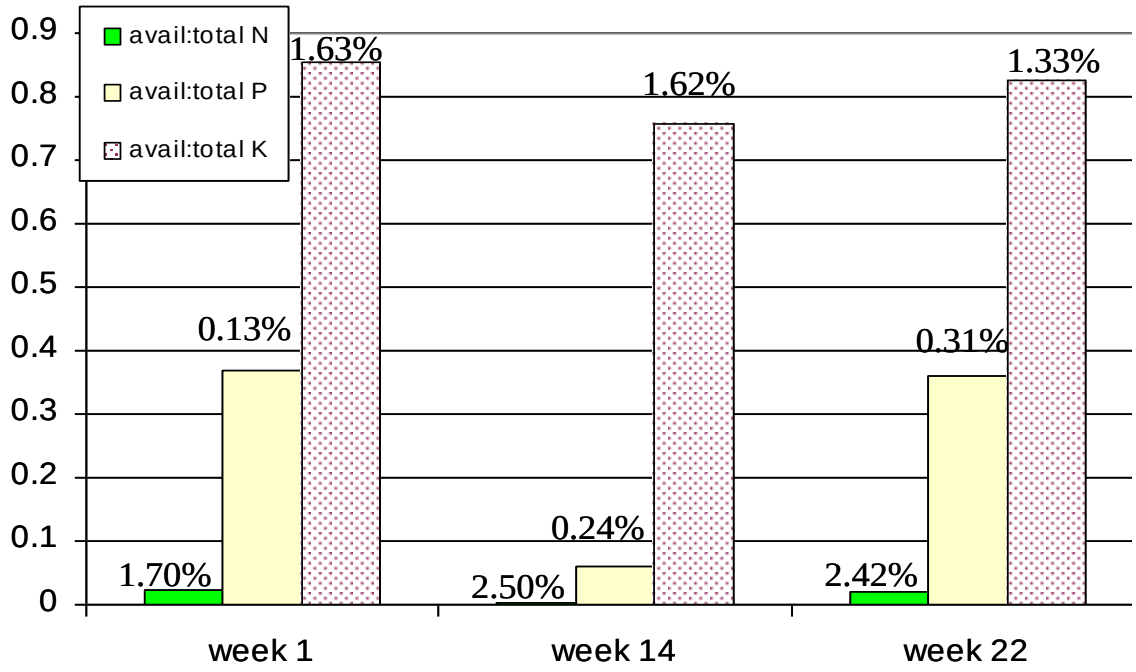

Figure 2: Changes in the proportion of nutrients available for plant growth during the composting cycle (1.0 is totally available). Cotton trash with a high proportion of fine particles (<10 mm) was used as the raw material. Dotted bars are potassium, pale bars are phosphorus, and dark bars are nitrogen. The percentage values above each bar are the total concentration of each nutrient in the compost at that stage of maturity. This fine, nutrient-rich compost is not suitable for use as a mulch.

Within a depth of several cm (refer to **Figure 1**), excessive microbial activity could starve plant roots of oxygen, nitrogen and phosphorus. In **Figure 2**, microbes took up luxury levels of both nitrogen and phosphorus during the active composting phase (week 14), and would have starved surface-feeding plants such as citrus and avocados if applied as mulch. Species such as earthworms are very sensitive to high levels of carbon dioxide, causing them to desert the affected area. Severe leaf yellowing due to **nutrient-drawdown** (the negative fertiliser effect) reduces crop yield and weakens plants, making them vulnerable to root disease.

Selecting a mulch produced from organics with a large particle size (**70% of particles greater than 16 mm**, classified as a mulch AS4454) avoid these problems, as air and water flows between the particles, and reducing the proportion of smaller fines (**not more than 20% of the particles less than 10 mm**) limits microbial activity (no negative fertilizer effect).

Working out Which Composts can be Used as a Mulch

Composting organics consisting of predominantly larger (>16 mm) particles in the **active phase** for a minimum of 3 to 6 weeks (**pasteurized**) improves the soil conditioning properties of a mulch (refer **Can Do Sheet 19** Determining the Soil Conditioning Properties of Your Compost). A long-stemmed temperature probe can be used to verify the temperature within the heated core of the windrow exceeds 55^0C for a minimum of 3 to 6 weeks, with a minimum of x5 turns during this period ensuring all parts of the windrow are pasteurized to kill weed seeds and pathogens.

However, not all biologically stable composts can be safely used as a mulch. Some large particle-sized green waste composts may contain high concentrations of potassium (a salt), especially if they were produced from fresh, lush, green prunings. If used at the high application rates required for a mulch, the potassium may chemically burn seedlings and soil animals (like urine patches in lawns). Salts can also concentrate in compost, if a salty water supply was used to water the windrows. Along with the beneficial salt potassium, the salts sodium and chloride burn plant roots and germinating seedlings if applied at too high a rate.

For example, if the cotton trash compost in **Figure 2** is used at the low mulch application rate of 6t/ha (assume 4.2t/ha dry weight), **56kg/ha** of potassium would be applied. This is the amount recommended for cereals and some horticultural crops. At the higher rate of 75t/ha (53t/ha dry weight), a total of **698kg/ha** of potassium would be applied - way in excess of most horticultural crop requirements, and may explain the seedling emergence failure in two successive cotton crops, and a final yield decline of 30% as recorded in cotton trash mulch field trials in Australia.

Testing to Ensure Your Mulch is Safe for High-Rate Application

- Select organics that contain >70% by mass of particles larger than 16 mm, that have been composted at temperatures of 55^0 C or above for a minimum of 3 to 6 weeks.
- Request a testing laboratory to use methods specified in the Australian Standard for Potting Mixes (AS3743) to determine the pH and electrical conductivity (saltiness). A pH within the range of 5.0 to 8.0 and an electrical conductivity of less than 2 dS/m should be safe for high rate application.
- Request a testing laboratory to use methods specified in the Australian Standard for Landscape Soils (AS4419) to determine if the soluble phosphorus levels are less than 3 mg/L for P-sensitive species, or less than 10 mg/L suitable for high rate use as a mulch.
- If using green waste, or if your mulch is contaminated with soil (refer **'Can Do' sheet 18** on **Site Preparation and Management**), the mulch may be contaminated with heavy metals or pesticides. Request a testing laboratory to determine the concentration of chemical contaminants using the methods and limits specified in the Australian Standard for Composts (AS4454).

These are the minimum tests recommended to ensure that your compost is safe for high rate application to soil as a mulch, to deliver the soil health benefits described above. If you would like to know more about the soil conditioning properties of your mulch, refer to 'Can Do' sheet 19: Determining the Soil Conditioning Properties of Your Compost.

Sheet updated 12/2010