

# DOING YOUR OWN FIELD TRIALS WITH COMPOSTS



A Natural  
Heritage  
Trust  
funded  
project

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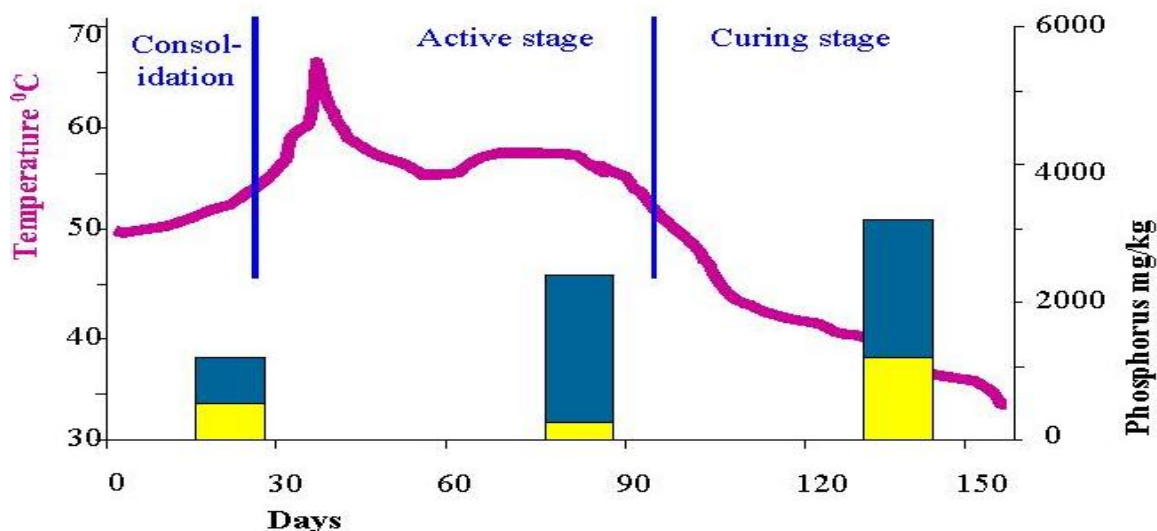
A **compost** is the end-product of the **microbial** breakdown of organic matter. **High temperature** composting favours the activity of **heat-tolerant microbes**, which are renowned for destroying toxic chemicals such as pesticides. Vermicomposts (with worms) are excluded from this definition as worms cannot tolerate heat, and the raw material requirements for processing are comparatively more restricted (refer 'Can Do' sheet 7 'What is a quality vermicompost').

## Biological Transformations In A Mature Compost

The three stages of composting are:

- 1) **consolidation** when raw materials (feedstock) are mixed with water (to field capacity), formed into a windrow and the bulk density of the windrow is established;
- 2) **active stage** when the core temperature is maintained ideally between 50 and 65°C; and
- 3) **curing stage** when the core temperature drops and nutrients are released in the **inorganic form** (figure 1 and refer to 'Can Do' sheet n° 4 'A Practical Guide to On-Farm Co-composting').

In a **mature compost**, microbes have converted the readily available organic matter into humic acids and microbial cells. In contrast **immature** composts may contain partially broken down chemicals which may be **toxic (including ammonia N)**, and high microbial activity inducing **nutrient draw-down** if the compost is applied to growing plants.



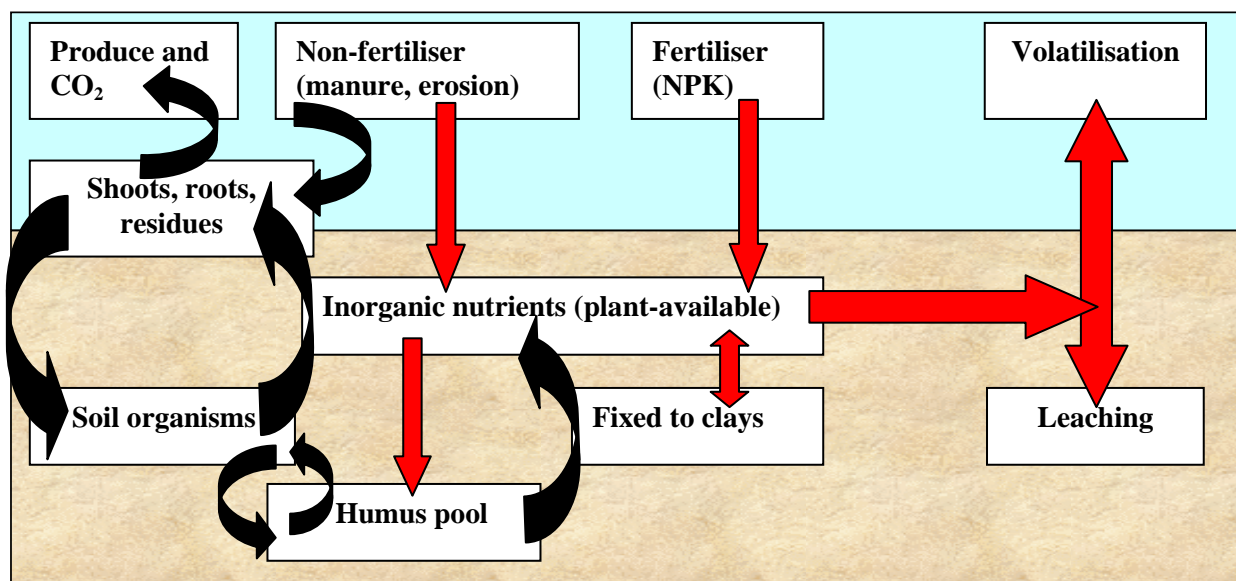
**Figure 1:** Changes over time in a cotton trash windrow during the 3 stages of composting (**Consolidation, Active** and **Curing**). Bars show changes in the total phosphorus concentration, with mineral P (available) in yellow, and organic P (slow-release) in blue.

If the compost is well mixed during the **Active stage**, then the survival of **weed seeds** and **plant** and **animal pathogens** will be **minimal**. Plant residues can be composted in their own right (figure 1). However **animal manures** are often included in the raw materials to increase the phosphorus (P), potassium (K), calcium (Ca) and trace element content. For example, adding 1 part by volume feedlot manure to 2 parts cotton trash in a compost mix improved the total P content at the curing stage from 3,116 mg/kg to 4,984 mg/kg.

## Characteristics Of A Quality Compost

A compost should ideally have about 50% of the P in the **mineral** (plant-available) form (**figure 1**), to improve its **net present value as a fertiliser**. To achieve this the compost must have undergone more than 4 weeks **curing**, during which time the water content of the mix will also decrease. At sale the water content of the product should be 25-30% by weight, with only enough moisture to suppress dust during handling.

At this stage, any chemicals that may be toxic to plants will have broken down, and sufficient P and K will be **available** for plant growth. However N may still be predominantly in the **organic** form (**figure 2**), which plants cannot use. Therefore if used as an alternative to conventional fertilisers, additional mineral N fertiliser may need to be applied (eg. blood or fish meal, or urea for conventional producers). The compost should be **screened** before sale, removing any stones or large particles.



**Figure 2:** Cycling of nutrients in the soil. Straight arrows show the pathways of inorganic (plant-available) nutrients. Curved arrows show organic nutrient pathways. To become available for plant uptake, organic nutrients must be converted to inorganic forms by soil organisms (insects and other arthropods, and microbes).

Composts which include **bark or timber** in the raw material, contain a higher proportion of **lignin** and other phenolics. In the **immature state** these compounds contribute to plant toxicity. However after decomposition, they assist in controlling soilborne diseases. For this reason, mature timber-based composts are preferred in potting media for plant nurseries. Raw materials high in **lignin** also provide higher concentrations of **humus** (**Figure 2**), compounds which improve the nutrient (**cation exchange**) and water-holding capacity of soil.

## Standards For Australian Composts

Composting is a robust biological process, based on the recycling of **organic carbon**. For this reason, many different raw materials ranging from crop residues to dead animals to industrial sludges may be included. However in **poorly managed** composts, animal and/or plant pathogens, pesticides and/or other chemical residues may not be adequately broken down.

Controlling the **quality** of the raw materials and the **temperature** and **turning** dynamics, will produce a more uniform product. Hence **quality assured** composts should specify both the **raw material inputs** and the **process control** methods. **Monitoring the temperature** is the most direct way to verify the level of process control achieved.

**Standards Australia** has developed a standard for composts, soil conditioners and mulches (Australian Standard 4454 1999). Accepted ranges for pH, heavy metal content, high temperature treatment and nutrient content are specified. However most of these ranges are generic, and do not relate to the agronomic requirements of specific soil types and crops. The standard for potting mixes (AS 3743 1996) is more prescriptive, focussing on the needs of container-grown plants. Standards for fertilisers and soil conditioners have also been developed by the organics industry. For example the **Biological Farmers of Australia** (BFA 2002) prohibits the use of raw animal manures, recommending composted material instead. Raw materials containing any pesticide residues, heavy metals or other listed contaminants are restricted, depending on the outcome of chemical testing.

Composts containing **biosolids** (treated industrial and domestic waste sludges) are the most likely to have a high **heavy metal** content. **Slurry** from intensively farmed livestock may have **cadmium** present, as a contaminant of the superphosphate historically included in some feed rations. Metal concentrations will be highest in **sludge** accumulating in anaerobic ponds.

For **one-off applications** for land reclamation or for continued use in forestry plantations, heavy metal contamination may not be an issue. However some food crops such as peanuts preferentially accumulate heavy metals, and relatively low concentrations of zinc, copper, nickel and cadmium are toxic to beneficial soil bacteria. The level of repeated applications of a compost containing heavy metals to a soil, is determined by the capacity of the soil to **fix** the metal to clay particles or organic matter (**figure 2**), and the ease of uptake by plant roots. If using a compost based on biosolids, seek government advice on the potential of your **crop** plants to **bioaccumulate** heavy metals in your particular **soil type**.

### **Getting The Most Out Of A Compost Application To Soil**

Expect to pay more for a **quality-assured** compost (raw materials specified, temperature and turning records kept, full nutrient analysis including total NPK **and at least** available P - preferably nitrate N: all other parameters within AS 4454 1999 specifications). If the compost is not quality-assured, at the very least ask for specification of the raw materials and some indication of the temperature and turning management. Depending on the price paid, expect to undertake chemical analyses of the compost for **at least total NPK**, and **available P**.

If the compost is to be repeatedly applied on an environmentally and economically sustainable basis, then the **immediate** crop requirements for NP and K (mineral component), and **future** crop requirements (organic or **slow-release** component) must be considered. Soils differ in their capacity to store P, with any excess entering and adversely affecting the health of our waterways (**figure 2**). To avoid an excessive soil build-up of P, we recommend that compost should be sold after curing when ideally **50% of the P is available**.

In most mature composts, most of the N will be organic, **unavailable** for plant uptake. Therefore the upper limit of application should be based on either the **mineral (available) P and/or K requirement** for early crop growth. Use soil tests for nitrate N and plant-available P to adjust the rate of application of organic and/or conventional fertilisers over time, as the organic N and P is mineralised (3 to 6 years depending on climate and/or irrigation).

Any nutrients in the **organic form** (most of the N, 50% of the P, but only 10-20% of the K) will become **mineralised over time**, depending on the temperature, water content and microbial activity in the soil. Testing for **available** NPK levels at the start of the next cropping cycle, will enable you to get the most out of earlier compost applications. Composts based on animal manures may also have a high concentration of soluble calcium, magnesium and trace elements. Experience in some soils indicates that the benefits of a high rate of compost application (5 to 10 tons per ha) may be measurable for up to 5 years later.

However if the nutrient content of a compost is low, application rates may relate more to improving the organic carbon content and/or the nutrient holding capacity of the soil. The combination of green manuring and compost application can improve the structural properties of degraded soils, over a relatively short time. A chemical analysis of the **cation exchange capacity** of the compost (a property of humus) is the best index of nutrient holding, with improvements most evident after application to sandy soils. The **Walkley-Black** test is the best index of biologically active **organic carbon**.

### **Benchmarking The Performance Of A Compost**

Composts provide a range of **soil health** benefits in addition to nutrient inputs. To test for evidence of these, select a paddock on your property where the **organic carbon** levels have declined (sometimes associated with increases in root disease severity), or where recommendations for the application of **gypsum** have been made. Select the **upper limit** for compost application based on either the **fertiliser P or the K** requirement for the early growth of the crop. Be prepared to undertake your own field trials for at least 3 or 4 growing seasons. Problems that take decades to develop will require more than one season to repair!

Crops known to be strongly dependent on **mycorrhizae** may benefit more from compost application than from inorganic fertilisers, due to the **slow-release** of P. **Mycorrhizae** are beneficial root-inhabiting fungi that improve the uptake of nutrients such as P and zinc, and assist in the control of **root diseases**. Chick-peas and other legumes, sunflower, cucumbers, capsicum, onion, sorghum and cotton are strongly to moderately dependent on mycorrhizae. Monitoring the performance of these crops to compost versus conventional fertilisers over time, may provide evidence of the soil health benefits of compost.

Apply compost to alternating strips of the paddock (adjusting N and P levels for early crop needs), and conventional inorganic NPK fertiliser to the remainder. **All other management operations must be the same across the paddock**. Compare rates of emergence and seedling vigour, the incidence of disease and insect attack, and of course, plant yield at harvest. The ability of a plant to respond successfully to attack by pathogens and to repair insect damage depends on the availability of circulating carbohydrates. Some growers use a **refractometer**, to compare plant vigour.

**Refractometers** are conventionally used to measure sugar concentration in ripening fruit, and are available from horticultural or specialist organic suppliers. Cut a leaf off at the petiole, or use a garlic crusher to extract sap from several recently expanded leaves. Place 3 drops of sap onto the refractometer and take a reading. Test 10 plants from the compost, and ten from the conventionally fertilised strips. Are the compost values higher? The timing of testing (irrigation, time of day) will affect results, as will the growth stage of the crop. However differences may still be documented, provided that your field trials are planned objectively and that all other management practices are kept **the same across both treatments!**