Hot Compost - a maker's guide *Joel Meadows*

Notes to accompany video. **-Watch Video here**

Watch Q & A session after video here (skip to 39mins)

There are lots of ways to make compost; plastic open bottom bins, compost tumblers and worm farms are common commercial offerings, as well as homemade bins bays and worm systems or just a pile in the corner of the garden.

There are also lots of reasons why people make compost; getting rid of organic waste/materials, improving our garden soil and reducing greenhouse gas emissions (GHGE).

These notes and the accompanying videos focus on 'hot composting', a process that uses the thermophilic (heat loving) microbes present in and on organic material to generate heat to accelerate the composting process. Hot composting uses that microbial heat to 'cook' the compost, which make the process fast, clean and low on GHGE.

Composting and gardening go together

Turning our garden and kitchen "waste" into compost for our garden is a beautiful symbiotic process that links household to garden, eating to growing and people to the land.

The greenhouse implications of compost

Organic material breaking down naturally will release carbon dioxide (CO_2 - the principle greenhouse gas), but this is not considered a part of human caused (anthropogenic) climate change, just a natural part of the carbon cycle, so some CO_2 emissions from our composting are 'OK'.

Putting organic material into the rubbish bin and having it buried in a landfill, or in a wet mass in the bottom of an airless compost bin leads to anerobic decomposition (breaking down of organic materials without oxygen) which produces methane gas, a potent (at least 30 x as potent as CO_2, if not lots more depending on how long it stays in the atmosphere) greenhouse gas.

Some forms of composting can also lead to high levels of Nitrous Oxide (N_20 - a very potent greenhouse gas – almost 300 x CO_2) being emitted. This is a loss of potentially beneficial nitrogen from our compost and garden, so it is a waste and a pollutant.

Excess Nitrogen levels in a compost will also lead to ammonia (nasty stale urine smell) being released. Though not considered a dangerous greenhouse gas, ammonia loss is also nitrogen loss from our compost and garden.

Good composting practice will reduce both methane and nitrous oxide production and so can be a part of good greenhouse gas reduction strategies on a small and large scale.

Hot Compost ticks the boxes

Using the microbes present on our organic waste materials we can mix them up in the right quantities and heat the material in our compost heap to over 60 degrees Celsius. In the process we can make top quality clean compost with a much lower greenhouse footprint than throwing food, kitchen and garden waste in the rubbish bin, and even reduce the emissions on a poorly managed compost 'heap' in the corner of the garden or in a sealed bin.

The magic recipe

1. **A cubic meter of material minimum and a structure to contain the material**
2. **A carbon: nitrogen ratio of about 25-30:1**
3. **A diversity of materials to give us a nutrient rich blend**
4. **Layering**
5. **The right moisture content**
6. **Oxygen through the whole pile**

1. Volume of material and something to contain it

To make a hot compost work we need to start our pile with something like a cubic meter (1 meter wide x 1 meter deep x 1 meter high) of material. This is easiest to do if we have three sides to stack the material up in, and is even better with a removable fourth side, to make a box.

The wall of this bay can be made from anything really; timber is common (though will rot over time – don't be tempted to use treated timber), corrugated roofing can be used, straw bales stacked up, even four star-pickets and three old timber pallets will do.

To make the system work smoothly it is best to have three bays, each of the same capacity, to allow building up of materials and turning from one bay to the next. Walls of bays can be shared to reduce the amount of material to construct the bays.

Some people worry over bay sides that are not permeable to oxygen. If we make our bays with the right blend of woody enough material we are pretty unlikely to make a pile that goes anerobic and smelly, so I worry less about the sides of the pile and more about what goes into it, but permeable sides could help, though might dry out the pile in hot windy conditions more than solid sides.

2. Carbon: Nitrogen ratio in balance

This sounds more complicated than it actually is. All living things have carbon as a building block. Most will have nitrogen in some quantity, even if very small. The Carbon:Nitrogen ratio (C:N from now on) of a good hot compost pile will start out at about 25:1 – 30:1.

Now I have never measured this, or weighed out ingredients, but with a few indicative charts and a completed few piles under your belt you will 'feel' the C:N ratio. The ingredients listed below all have indicative C:N ratios, keep in mind the material you source will vary from this by small or even large amounts, but don't worry too much, you will get a feel for assessing the C:N ratio of materials.

The easiest way to divide things is into those with higher nitrogen levels (those under our target 25-30), and those with higher carbon ratios, usually well above our target.

The other simple 'rule' that people suggest when starting out in composting is to divide ingredients into 'Greens' and ' Browns'.

Greens being more nitrogen rich materials like grass, leafy green weeds, kitchen scraps etc. The exception to the colour system is manures like chook and pig (and human) as these are very high in nitrogen, but (usually) brownish.

Browns are straw and woody weeds, leaves, paper, sawdust and cardboard. This is a basic way of dividing the ingredients and layering one green one for one brown as we build a compost pile.

3. The Ingredients

The more diverse the range of our materials the better the compost is likely to be. We could theoretically take a pile of high nitrogen chook manure and blend it in layers with high carbon saw dust till we have a 25:1-30:1 ratio.

This will heat up and compost, but it will be pretty mono-cultural compost, lacking in the nutrient richness of a diverse pile.

Ingredients featured in the video and their (approximate) Carbon: Nitrogen ratios are listed below with some basic info on what to look for:

3.1 Straw – Wheat Straw 80:1

Straw is a 'waste product' of the industrial agriculture system, there is a fair bit of it around in wheat producing regions. Straw is the stem of a grass that has had its seed head cut off, not to be confused with hay, which is grass that has been cut when it is at its most nutritious, dried and stored for animal food. Hay has a high nitrogen content, whereas straw is more carbon rich.

Wheat straw has hollow, coarse stems which help get oxygen path ways deep into the compost pile.

Straw can be bought direct from local farmers who advertise in the local paper. Small squares, large rounds and large square bales are all usually available. The larger ones are more cost effective, but very hard to move around. Small squares are more convenient.

3.2 Manure – Horse 25:1

Different manures have different C:N ratios. You can kind of gauge it by how offensive they smell (high nitrogen), or conversely how much like chopped up grass they seem like (high carbon).

Some manures are sold with bedding material, like sawdust and straw from stables etc. This extra bedding will increase the carbon content and lower the nitrogen, so it is better not to pay for manure if it is half straw/sawdust, or adjust the price accordingly.

Horses don't like to eat grass close to where they have defecated, so people who keep horses in a small area need to regularly clean up after they're horses to keep them in one paddock. This cleaned up manure is often sold in bags by the side of the road. Check the quality of what is on offer in a bag before you buy too many. Talk to the owner, they will probably be happy to give it for free if you do the collecting.

In winter it can be wet and heavy, in summer it might be almost powdery. These variations will have to be adjusted in the compost pile with additional wet or dry materials, and or water.

If you can chat with the horse's owner check about worm treatments, as residue worming treatment can kill compost worms. Best not to collect manure within a few weeks of treatments.

Some C:N ratios of other manures:

Aged chicken manure: 7, Used poultry bedding: 15:1, Fresh cattle and sheep manure: 15:1 Human manure (humanure) 7:1.

Humanure:

Human waste is available everywhere people are, so in some ways it is the easiest manure to access, but because of the potential pathogen (dangerous microorganisms) load it must be heated before it is safe to use on food gardens. The heat generated by a hot compost pile can be used to kill the pathogens by effectively pasteurising the humanure, but the time and the temperature are critical.

If you are interested in humanure processing have a look at Joseph Jenkins book, the Humanure Handbook, and his website - **http://humanurehandbook.com/**

3.3 Leaves – 60:1

The leaves from most deciduous trees are worth raking up for adding to a compost pile. Eucalypts and any other trees with very oily leaves are best **avoided**. There is still a good deal of remnant nutrient in autumn leaves, and many oaks produce amazing soil under their leaf fall.

3.4 Woody weeds/Garden clean up – 25:1

These are the spent plants we pull out of our vegie gardens, or the weedy plants that have got tall and seedy. They might still have leaves and a good nitrogen load, in fact they are probably close to a perfect compost balance on their own, but we do need diversity in the pile.

I roughly chop these plants up as they go into the compost pile. Bits that are too long can make turning the pile hard, and they might not fully break down. Chopping roughly into 20-30 cm lengths will keep the pile workable, but also very well oxygenated (like straw but thicker).

Hot compost will kill off most seeds with its heat, but if you are not confidant about getting your pile hot enough, or you just don't want to risk it, then avoid putting seeds of noxious weeds into your compost pile.

3.5 Leafy weeds/Dynamic Accumulators – 15:1

Leafy weeds (this can include lush grass) are like manures, but green. Look for plants with deep root systems that will be drawing nutrient from deeper down. These 'Dynamic Accumulators' will add things missing from shallower rooted grasses and plants. Comfrey, borage, dock and nettle are all fantastic for this, but don't be limited, any 'weeds' can be added.

3.6 Kitchen scraps – 25-:1

These are the bits of food we chop off, but don't eat, like stems, and outer leaves and rotten bits. These are perfect for the compost.

3.7 Food waste – 20:1

Food waste is the crust of bread we didn't eat, or the moldy cheese, or the scraped out cereal bowl with milk dregs. We can compost these things, but we will attract **rodents** with these tasty bits. They are best fed to chooks or pigs etc. to reduce the rodent load, but they can be composted, and make a great addition, but you'll have to watch out for rats and mice and some savaging birds. ***See the 3 x 3rds approach below for a tip on how to manage.***

3.8 Paper 175:1 Cardboard, 350:1 Sawdust 325:1

I lump these three together because they are very high in carbon, but very low in nitrogen, or anything that will feed our garden.

These can be added to the compost, but if they make up too large a fraction of the total ingredient list your compost will be quite 'empty' of nutrient at the end.

Also watch out for plastic coatings on card and paper, they turn up as little plastic pieces at the end of your composting, and it is very frustrating to pick them out.

3.9 Biochar 100:1 (not all the carbon is available)

Biochar is organic material that has been burned in a low oxygen environment, and taken to charcoal, but not burned to ash. It is a great addition to compost, and will provide amazing microbe habitat, and long-term carbon retention in the soil.

If fact you can actually start drawing carbon out of the atmosphere and locking it, long-term in the soil in your backyard.

Making biochar details is too complicated for these notes, look into it at www.thebiocharrevolution.com.

3.9 Seaweed 15:1

Much of the nutrient from the landmass of Australia has eroded and washed into the sea, the sea is a great place to go looking for all those missing nutrients from our soil. Fortunately, plants grow in the sea, and draw those nutrients up into their bodies, and if we harvest a sustainable amount of those weeds of the sea, we can return some of the missing nutrition to our garden via the compost pile.

- Rinse off the salt water, and either chop and add directly to the pile, dry and add as required.
- Be aware of the regulations around sea-side harvesting. Harvest respectfully.

3.10 Lime (agricultural lime or slacked lime)

Some people recommend adding lime to the compost pile to balance out the acidic ingredients from the kitchen and garden. Lime is alkaline and will reduce acidity, and will add calcium to the compost/garden.

Unless you know your garden soil, or compost is acidic, I'd **avoid** liming the compost. If you need to correct acidity imbalance, do that in the soil. Hot composts have a good balance of ingredients, so usually are pretty close to neutral. **Don't** use quick-lime in the garden.

3.11 Garden soil with clay

This is a bit of a 'secret ingredient', but without it you won't make great compost! It is the missing ingredient from most municipal composts, which is why they are usually so lame (that, and way too much carbon).

Aim for about **5%** of you pile to be thin layers of garden soil evenly distributed though the pile. The soil and its clay content will make sure the best soil organisms are there to get the pile going, will help to retain nitrogen, and will put the brakes on the pile getting too hot.

It really lifts the quality of your compost, don't miss it from the list.

3.12 Other common compost ingredients

Grass clippings: 20:1 Coffee grounds: 20:1 Wood ashes: 25:1 Pine needles: 80:1

4. Layering

Now we have our ingredients together we are going to start layering them up in the first of our three compost bays. We'll put a good layer of woody weeds and straw down first to make sure we have oxygen access at the very bottom of the pile. Then we'll start layering up, like a lasagna, with a layer of nitrogen rich material, then a layer of carbon rich.

All at once or bit by bit?

The hardest things about hot composting is trying to get all the ingredients for a cubic meter pile all together at the same time. Some people like to do it this way, and you can be pretty sure what is in the pile.

I do a system I call the 3 x thirds. That is where I layer up about a third of the first compost bay with a good balanced mix of ingredients (C:N, moisture and oxygen access all good). It is not the full cubic meter, so it won't get supper hot, but it will start to heat up, and often hot enough to keep the rodents out.

You can then build the middle third with kitchen and garden waste as they come, layering up a carbon rich layer on top of each deposit. This can be added to for weeks or even months depending on you access to materials.

The final third can be blended up when you are ready or the pile is starting to fill up the bay.

5. Moisture

As we are building the pile we'll be checking the moisture content of the ingredients and the layers. Everything wants to be wet, but not soaked, like a sponge that has been wrung out, but is still damp to the touch.

We might be able to get this moisture just right with our ingredients, but in the height of summer, or if our ingredients are dry, we might need to wet up the layers as we make the pile. In summer, I will water an active compost pile on my gardening rounds, just to keep it moist in the driest weather.

6. Oxygen

If we have our ingredient blend right, with enough woody and fibrous materials we should get oxygen through the whole pile. Some of the more woody weeds might not fully decompose on the way through the piles, I just throw those bits back to the start where they add a bit more carbon to the next batch.

If our particles are too fine, or too wet or both, the pile, or parts of the pile can collapse and squash the oxygen access. This will start to smell and will indicate the pile has gone anerobic and we are losing nitrogen for the pile, and are probably giving off methane.

If this happens, you'll need to turn the pile and add more carbon rich materials as you do to balance the nitrogen, reduce the sloppy spots and get oxygen pathways right inside the pile.

Turning/tumbling

Once you have a full pile it is ready to turn. In turning we are looking to mix the layers of our lasagna pile so they are fully mixed up. We also want to turn the hottest inner part of the pile to the outside, and the coolest outer parts to the inside to give every bit of the pile a change to get nice and hot.

If everything is right (C:N, moisture and oxygen access all good), or close to it, the pile will get nice and hot (even over 60 degrees) and might hold that for several weeks or more. Once it starts to cool down (you can monitor the internal temperature with a metal wire pushed into the middle of the pile - just be careful not to get burned!) it is time to turn again.

Again, we are blending the layers, mixing inside to out, and outside to in, and giving it a good aeration. Again, it will heat up, and again start to cool. Once it is garden temperature you could put it out on the garden, but if you wait, some magic will happen.

Temperatures

Unless you are trying to kill pathogens or weed seeds in your compost you probably don't need to be too particular about the temperature you pile reaches. If you have got all the elements right it will get hot. My piles often get up to 68 degrees Celsius, but don't worry if you pile only heats up to 50 degrees, in truth very hot and quick piles don't make the best compost, and taking the whole process a bit slower can produce better results. The quantity of soil will have an impact on temperature, the more you add in the layers, the cooler the pile will be, and potentially the more nutrient (particularly nitrogen) you will retain.

If the pile can be at 50°C for at least a day, or about 45°C for a week you will still hit that 'pasteurisation' temperature zone that will kill pathogens and lots of seeds too. Keep in mind the core of the pile will be hotter than the sides, so take your temperature readings closer to the sides, and make sure you more the parts of the pile around when you turn/tumble, so the second heat up can work different parts of the pile.

Magic worms

Once the pile is cool enough your compost will fill with worms. If you give them a good few weeks to a month, they will work over your pile for you and lift the quality of your compost several notches. It takes a bit of patience, particularly if you are itching to spread it, but it is worth the wait.

Reducing the need for imported ingredients

It is good to be able to source you compost ingredients for your bioregion, rather than buying them in from far afield. Even better you can start growing things specifically to be ingredients for you compost. Those dynamic accumulators I mentioned earlier are a good place to start, but green manure crops, pathway plantings and garden edges can be used to grow bonus plants for the compost. Don't limit what you think you can fit in the garden, or put in your compost pile.

Happy Hot composting,

Joel Meadows - The Greenhand Institute

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