



# BIOCHAR

## What is biochar?

Biochar (or horticultural charcoal) is a charcoal-like substance that is manufactured from sustainable resources, using clean technologies, and which does not involve its rapid mineralization to CO<sub>2</sub>.

## How is biochar made?

Biochar is made by heating up organic matter in a metal kiln which restricts oxygen from entering (pyrolysis). For each tonne of wood,  $\frac{1}{3}$  tonne of biochar is produced,  $\frac{1}{3}$  tonne of bio-liquid and  $\frac{1}{3}$  tonne of an energy-rich gas. If the hot gas is recycled back into the reactor, the equipment is known as a retort. By restricting oxygen, the biomass does not burn to ash as in a garden bonfire. Most organic matter is 45 to 50% carbon by weight and normal burning in oxygen releases all this carbon as carbon dioxide to the atmosphere. By restricting oxygen, about 50% of the carbon is retained in the solid biochar, while the other half is released as carbon dioxide.

## What does biochar do?

Above all, biochar is a way of storing carbon for a long time — hundreds to thousands of years depending on where you put it or what it is used for. Other uses are being explored, but in two areas the results imply it could also help with soil ecology and plant growth and aiding digestion efficiency whilst detoxifying from consumption.

When organic matter is added to soils, such as compost, manure or kitchen wastes, microbes living in the soil devour the material for nutrients and energy fairly quickly. Within a decade or so, most of the carbon has been converted back into carbon dioxide. When biochar is produced, the carbon atoms arrange themselves into ring structures consisting of 6 carbon atoms. These rings are fused together in sheets and the chemical bonds between the atoms are strong — too strong for microbes to break them easily. For this reason, biochar stays in the soil for much longer than

the feedstocks from which it is made and removes carbon dioxide from the air, fixing it securely in soils for hundreds, sometimes thousands, of years.

Biochar can improve many types of soil, making them more productive (but not all).

Exactly how and why it 'works' is still being actively researched. Evidence points to the fact that biochar:

- Enhances plant growth and root development.
- Contains some nutrients such as potassium, phosphorus and magnesium.
- Increases microbial life within the soil: this helps to enhance plant growth through increased soil levels of available nutrients and better disease resistance and pest resistance.
- Has a very large internal surface area, providing a suitable location for chemical reactions to occur by which important nutrients are made more readily available to the plant roots in the soil.
- Reduces fertilizer requirements: biochar seems to be able to hold on to the nitrogen that is added to the soil in chemical fertilizers, releasing the nitrogen more steadily to the plant and reducing nitrate pollution to rivers.
- Suppresses methane emissions from the soil ( $\text{CH}_4$ , a global warming gas, potentially 21 times higher than carbon dioxide).
- Reduces nitrous oxide emissions from soil ( $\text{N}_2\text{O}$ , a global warming gas, potentially 300 times higher than carbon dioxide).
- Reduces the loss of added nutrients from the soil.
- Raises soil pH (i.e. reduces soil acidity).
- Is able to hold a lot of water and this helps provide water to plants in some drought-prone soils.
- Reduces heavy metal contamination in the soil (e.g. zinc, lead, cadmium, arsenic) as well as potentially toxic persistent organic chemicals.
- Increases soil aggregation, improving soil aeration.
- May also be used for its water filtration properties.

## **Do some types of soil benefit more than others from biochar addition?**

Yes. For example, sandy soils benefit more from biochar's water-holding ability.

## Biochar Soil Mixes

Biochar can be mixed with either potting soil, compost or peat moss: it is useful in lightening the soil and bringing out all its benefits.

**Terrariums** – Due to its absorbing properties, biochar can be used as a water reservoir, an odour absorbent and, at the same time, it prevents rotting of the roots. Biochar particles of between 5 and 10 mm can be deposited on top of small rocks in order to help with drainage.

**Orchids** – Orchid lovers around the world have discovered the virtues of adding biochar to most soil mixes.

**African violets** – Biochar has been used by African violet lovers since carbon is useful for this particular plant. A fine granular size can be added to the soilless mix in order to stabilize the humidity level and prevent it from fluctuating.

**Lawns** – Fine biochar powder used on lawns absorbs and eliminates excess amounts of fertilizer and chemicals present in the soil.

**Transplanting trees** – When transplanting a tree, place a few biochar pieces at the bottom of the hole before planting. It will absorb and purify any stagnant water and help with drainage.

## Does biochar need to be treated and how best is biochar incorporated into the soil?

For instant and best results from biochar, it does need to be treated and it is recommended that you add biochar to your compost heap/farm manure, leave it a month or so, and use the compost/manure as normal. The reason for this is that biochar can act like a sponge and when added to soils it could soak up the nutrients that the plant needs before the plant can get to them. By adding biochar to the compost/ manure you allow the biochar to absorb the nutrients and microbes from the compost/manure before you use it.

Soaking in a water butt full of compost tea is a very good way to pre-treat

biochar as well. The compost tea can be made from nettles, comfrey, worm cast, compost or any other microbe- and nutrient-rich material you can find.

If you are not concerned about pre-treatment, biochar can be used as a top dressing in the normal way: just spread over the soil and allow it to mix naturally. However, best practice would be to dig biochar into the soil to a depth of up to 30 cm and allow the soil to settle over a short period before planting. Fine granules of biochar are preferable and caution must be taken on windy days as biochar can be dusty (e.g. wet the biochar or use suitable protection).

## **How much biochar can I use?**

At the moment there is no research into maximum amounts of pre-treated biochars that you can add to soils. So for now it is suggested that users keep to the UK suggested maximum limits for biochar of 3 kg of biochar per square metre every 12 months.

## **How often do I need to apply biochar to my soil?**

It is recommended that you use a maximum of 3 kg of biochar, on 1 square metre of soil, every 12 months. For every 5 kg of biochar used, the carbon store is roughly the equivalent of 15 kg of carbon dioxide for hundreds of years, so the more used, the better it is for everybody, the plants and the planet.

At present, experts are debating whether it is better to add larger doses of biochar in a one-off application to soil, or whether it might be better to add smaller amounts over a number of years.

More importantly, at present there is absolutely no data on what the maximum amount of pre-treated biochar that can be added to soils at any one time. This is partly to do with the lack of large-scale field trials.

The half-life of biochar is still being investigated, although the current conservative estimate is a half-life of 400 years. In other words, if you put 1 kg of biochar into your soil, there will still be ½ kg of biochar left in 400 years.