Technical Note

Conditioning Biochars for application to Soils

James Joyce BE Chem (Hons) MBA PhD
Principal Technologist, Black is Green Pty Ltd
james@bigchar.com.au

INTRODUCTION

Biochars provide great benefits to soils, which are best achieved from pre-conditioned biochars. Conditioning involves two aspects, (1) charging to Biochar with plant nutrients and (2) inoculating (seeding) the Biochar with a combination of living organisms. After the biochar conditioning process is complete the Biochar can be spread on, or worked into, the target soil for the best results.

Expressed in a number of approximately equivalent measures, the rates that conditional biochar is added to soils varies in the ranges:

- 0.25 to 2.5 % by weight,
- 1 to 10% by volume,
- 2 – 20 tonnes/Ha, or
- 0.2 – 2 kg/m^2

Biochar is typically added during the planting stage, however smaller more regular additions to the soil surface are practiced for permanent plantings like lawns and gardens.

ABOUT THE AUTHOR

James is the principal designer behind the BiGchar interrupted combustion process for Biochar production from biomass residues.

James has a PhD in chemical engineering a Masters in Business Administration and 20 years experience in the sugar industry. He is not a soil scientist. This note is based on his observations from working with BiG's BiGchar product and readings on topics relevant to the use of biochar in soil. Some examples of other work are outlined at the end of this note.

Soil health is determined by a very complicated interaction between soil organisms, plant roots, organic chemicals, and inorganic chemicals. Fortunately it is not necessary to understand all the hundreds of complex interactions, as they all hinge off a handful of key principles. Get those right and nature will do the rest.

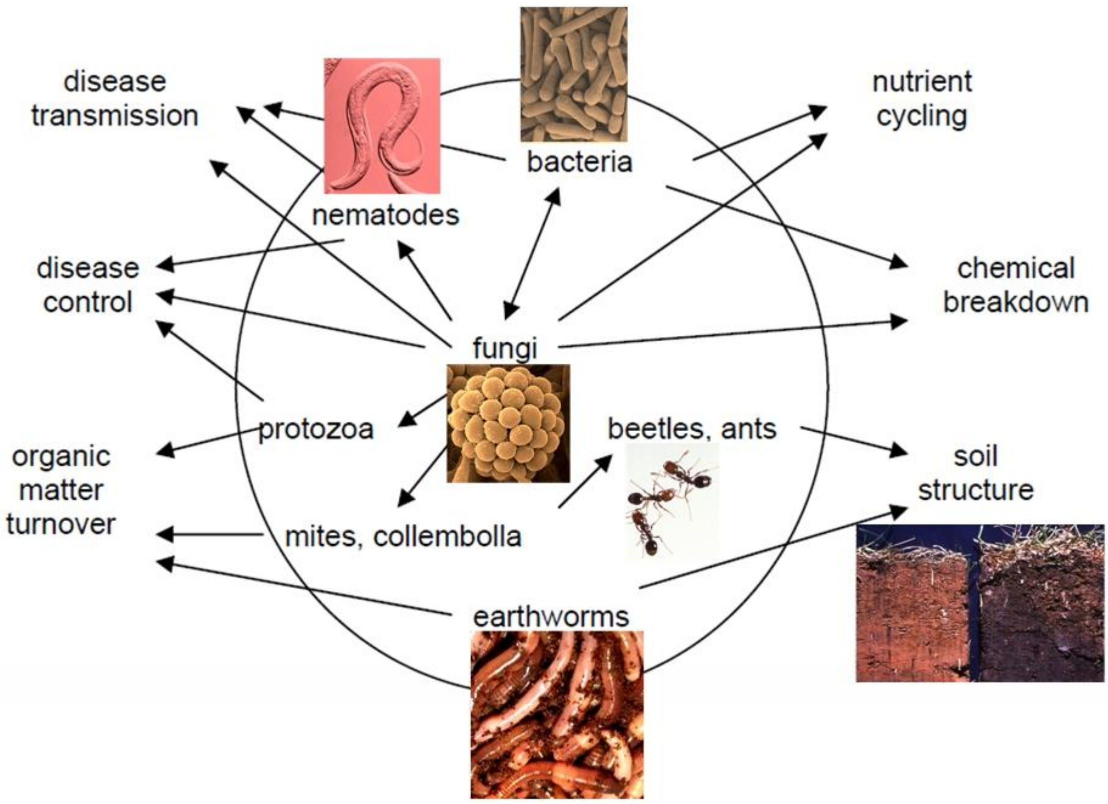
Provided the key principles of soil health, as explained in this note, are observed, then conditioned Biochars can be used with consistently positive results. Otherwise the response to Biochar can become "Russian Roulette".

The overarching concept expressed in this note is that best way to condition a Biochar is to create the right conditions for natural organisms to proliferate, which in turn are the same conditions as required for effective composting. Hence BiG recommends treating Biochar just like any other compost ingredient, as something that must be matured with due regard to moisture, pH, temperature, and carbon to nitrogen ratio (C:N), before adding to the soil.

HEALTHY SOIL 101

Figure 1 summaries the key interactions in a healthy soil. These span from the atomic scale (chemical reactions) right up to the macro-organism scale (worms and insects), as well as those related to purely physical effects (eg. surfaces, pores and between granules). The resulting chemical and physical equilibrium makes a healthy soil quite resistant to assaults from disease, moisture stress, nutrient stress, leaching, and erosion.

Figure 1.A Summary of the Interactions in a Healthy Soil

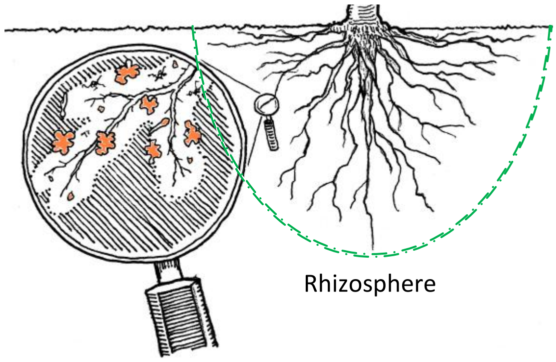


Just as in the human body, there is a constant battle in the soil and plant roots between the good bugs and the bad bugs—and at the same time, each bug struggles to survive the conditions presented by the environment itself. In a healthy soil, if any parameter becomes imbalanced, such as moisture, nutrient or pH, the system will endeavour to compensate. A health soil is robust. However, there are limits and prices to be paid if these compensation mechanisms are pushed too far for too long.

THE LIVING SOIL

The cornerstone organisms in soil are the microbes. Soil microbes are found primarily in two places: the top 2-3 cm of topsoil where they can "breathe", and close to root surfaces in the rhizosphere (Figure 2). The rhizosphere is the few centimetres (sometimes metres!) of soil that immediately surrounds the plant roots and is affected by chemical secretions from them, including energy providing sugars. Some of these secretions allow the plant to "communicate" with the microbes to encourage activities of mutual benefit. One of the key mutually beneficial activities is to maintain pH in the rhizosphere in a preferred range, which then assists the "mining" and transfer of nutrients from the soil to the plant.

Figure 2.Microbes and the Rhizosphere



The ability of microbes to "turn over" nutrients and to bind particles in soil is essential for plant growth and for the larger organisms living in the soil. The process of the macro-organisms feeding on the microbes further enhances soil structure--thus providing enhanced room for root growth, water/nutrient movement, and gas exchange in the soil.

One of the useful roles of biochar is purely structural. Because biochar is both porous and granular, each inter-granular space and intra-granular pore can, in time, become safe "housing" for microbes and fine root hairs (hyphae).

The soil microbe populations are in the first few centimetres of the soil and around the plant roots. So it makes sense to place Biochar in these locations. Anywhere else is likely to be of less direct benefit.

Mycorrhizae (1 + 1 = 3)

Within the rhizohome there is the potential for forming a mycorrhizal association, which is the colonisation of fungus on or in the plant roots. The mycorrhizae blur the distinction between where the living soil ends and the plant starts. The key benefits of mycorrhizal structures over the absence of mycorrhizae are:

> Inoculating a soil with properly conditioned biochar can accelerate the formation of highly beneficial mycorrhizal structures.
>
> Microbes need decomposed organic matter to feed on. Compost provides this.

- Mycorrhizal structures can accumulate as much as 100 times more reserves of water and nutrients.
- Increased rate of nutrient and water capture.
- Nitrogen fixing directly in response to plant requirements.
- Improved natural suppression of pathogens.
- Improved soil structure.
- Enhanced root growth.

Sounds too good to be true? There are limitations; the most prominent are that healthy mycorrhizae:

(a) can take years to fully develop (unless carefully inoculated and nurtured) and

(b) can be damaged very quickly if the soil is grossly disturbed or sterilised by artificial chemicals.

The well-established role of biochar in encouraging fungal growth indicates that inoculating a soil with a properly conditioned biochar can encourage the formation of highly beneficial mycorrhizal structures, but in timeframes of *weeks* rather than months or years.

Breakdown of Organic Mater – The Role of C:N

Healthy soils require decomposed organic matter and nutrients. This is important in the context of inoculating biochars and/or soils to improve productivity, because it is not sufficient to put a "bunch of bugs" into a biochar or a soil that has no decomposed organic matter to feed them.

Organic matter cannot be used by plants as food until it has been "processed" by microbes.

It is therefore beneficial to compost biochar. Composting establishes a large microbial population without necessarily having to resort to the application of a "high tech" inoculating mixture. The key point here is that if you co-compost biochar with other organic material you really don't need to seek out any special brews of proprietary microbes. What you need will already be present in healthy compost. In fact, given the tendency for soils to find their own balance, adding exotic organism is just as likely to be an expensive waste of time since the native microbes will progressively out-compete the exotics in a relatively short period of time. This is repeatedly borne out by countless studies.

Biologically speaking, there are two pathways in the decomposition of organic matter—putrefaction and fermentation. Putrefaction provides nutrients for plants, but also creates a pathogenic condition within the soil, not to mention foul odours, nutrient loss, and a reduction of available nutrients to plants.

In contrast, the fermentative pathway tends to makes nutrients more available to plants. Fermentation is the target mechanism for composting. Fermentative cultures can be created by inoculating specific microorganisms and this is the basis of many commercial fermentation offerings, such as the Bokashi system (see sidebar). Echoing the introduction to this note, provide the right conditions and fermentation will commence naturally.

THE BOKASHI SYSTEM

Bokashi is a commercial composting system that uses a commercial mixture of microorganisms to inoculate composts.

Soil science has determined that the fastest way to produce good soil ferment (compost) is to commence with a C:N ratio somewhere around 25 to 35 parts carbon to 1 part nitrogen. If the C:N ratio is too high, indicating excess carbon, decomposition is slow. If the C:N ratio is too low (indicating excess nitrogen), putrefaction or ammonia formation can occur, resulting in reduced microbial activity and a very low or very high pH, respectively.

Outlined in Table 1 are the average C:N ratios for some common organic materials. For the sake of simplicity, the materials containing high amounts of carbon are usually considered "browns," and materials containing high amounts of nitrogen are considered "greens". To achieve the correct C:N ratio for composting, the common rule of thumb is 1 volume of greens to 3 volumes of browns.

To this common terminology, the concept of "blacks" can be added to denote the use of biochars in the composting process. This process is sometimes described as "loading," "charging," or "inoculating" the biochar, although these terms are also used when chars are simply pre-soaked in a nutrient-rich liquid mixture immediately before addition to the soil.

Biochars have a high recalcitrant (fixed or inert) carbon content and a low organic carbon content. Typically, only 10-30% of the total C in the biochar is mobile and available to enter into the C:N balances. The C:N ratios for "blacks" in Table 1 are adjusted to better represent the portion of the C available to enter into the organic cycle.

How to Use the C:N Table

> The commencing carbon to nitrogen ratio for a good compost blend is 25 to 35 parts carbon to 1 part nitrogen.

The C:N ratio of a combination of components is calculated as follows:

$$\frac{\text{Volume of Ingredient A} \times \text{C:N ratio} + \text{Volume of Ingredient B} \times \text{C:N ratio} + \ldots\text{etc.}}{\text{Total volume of ingredients added}}$$

For specified ingredients, the volumes are adjusted until the desired ratio of around 30 is achieved. To achieve the right ratio for conventional compost mix using lawn grass clippings and sawdust, the formula is:

Volume of Lawn Grass x 15 + Volume of Sawdust x 450 / (Total volumes) = 30

Here are a few examples of working with this target:

<u>Example 1.</u>

Let's try to achieve the target C:N ratio of 30 by using 1 scoop (volume) of grass to 10 scoops (volumes) of saw dust. The result:

C:N = (10 x 15 +1 x 450) / (10+1) = 54

This is too high, so it needs more N—specifically, grass.

After a couple more tries we find that 28 grass to 1 sawdust puts us spot on our target.

C:N = (28 x 15 + 1 x 450) / (28+1) = 30

What happens if we want to add some biochar to improve the permeability of the compost (for improved aeration) and provide better "housing" for the microbes ?

If we add 1 scoop of slow pyrolysis biochar to the above mix we get:

C:N = (28 x 15 + 1 x 450 + 1 x 100) / (28+1+1) = 32

Still well within our target range.

Table 1. The Carbon:Nitrogen Ratio of Common Compost Ingredients

Blacks = High Recalcitrant Carbon	Nitrogen	C*:N	Other notes
* *Adjusted for the fact that in chars, the available carbon for composting is 10-30% of the total C.*			
Slow pyrolysis wood biochar	0.1	100:1	Bark-free wood/sawdust. Mild liming effect
Slow pyrolysis green waste biochar	0.1	100:1	Moderate liming effect
Fast pyrolysis crop residue biochar	0.8	80:1	Mild to moderate liming effect
Slow pyrolysis rice husk and grass-type biochars	0.1	75:1	Moderate to strong liming effect
Fast pyrolysis green waste biochar	1	50:1	Mild to moderate liming effect
Wood ash	<0.1	25:1	High in inorganics. Strong liming effect.
Browns = High Organic Carbon		**C:N**	
Wood chips (bark free)	<0.1	600:1	Low in other minerals
Cardboard, newspaper	0.1	500:1	Low in other minerals
Sawdust	0.1	450:1	Low in other minerals
Wood bark	0.1 – 0.3	400:1	Resistant to composting
Rice Hulls	0.3	120:1	High in silica
Pine needles	1	80:1	Resistant to composting
Straw	0.7	75:1	
Corn stalks	0.7	70:1	
Leaves	0.8 -1	55:1	
Sugarcane trash	0.8	50:1	
Woody weeds	0.7 - 1	50:1	
Fruit waste	1 -1.4	40:1	Moderate levels of P & others
Peanut shells	1	35:1	
Greens = Low carbon / High Nitrogen		**C:N**	
Mixed garden greenwaste	0.9	30:1	
Hay	0.7	25:1	
Vegetable scraps	1.5	25:1	Moderate levels of P & others
Clover	1	23:1	
Mature compost	1	20:1	Ideally ~40% moisture
Rotted manure	1	20:1	
Seaweed	2	20:1	High in K and trace elements
Lawn grass clippings	2.5	15:1	
Herbivore manures	1.5 - 3	15:1	
Lucerne	1.5	12:1	
Chicken manure	6 – 10	12:1	Very high in P
Human and pig manure	3 – 6	10:1	High in P
Soil humus	5	10:1	Stable. Does not form ammonia
Bacteria and Fungi		7:1	Included for reference
Sewage sludge	5 - 6	5:1	High in P
Blood	10-14	3:1	High in P. Prone to putrefying.
Urine	15 – 18	1:1	High in P.
Meat scraps	5	<1:1	High in P. Prone to putrefying

The values indicated here for nitrogen and C:N ratio should be taken as a first approximation only. In practice there is much more variability in these values than implied in the table, especially for the biochars.

Example 2.

If we want to use more biochar, we could dispense with the sawdust and try 4 parts grass to 1 char:

$$C:N = (4 \times 15 + 1 \times 100) / (4+1) = 32$$

Along with the C:N ratio, it is still very important to get pH, moisture content and temperatures in the right ranges. The recommended ranges are summarised later in this note.

Direct Composting of Biochar

The previous examples showed how biochar could be composted in combination with other biomass, but what about biochar as the main ingredient? A commonly recommended source of nitrogen for direct-composted biochar is urine (C:N ratio of 1:1). Using the same wood char and our method above, we can achieve our target of 30:1 using the following:

$$C:N = (1 \times 100 + 2 \times 1) / 3 = 34$$

That means adding 2 litres of urine for every litre of biochar, which is probably more than it can hold unless it is added progressively so that excess water can evaporate. What we are describing here, in effect, is a biochar compost toilet, which is in fact used occasionally in India and elsewhere!

An alternative in many locations is chicken manure. Let's try that at one to one ratio with a fast pyrolysis green waste biochar:

$$C:N = (1 \times 50 + 1 \times 12) / 2 = 32$$

How about co-composting green waste and green waste biochar? If the green waste already has a C:N of 30, then any biochar we add will increase the C:N ratio. How much can we add? We find that we must keep the char to less than 1/3. That is, with 3 scoops of greenwaste and 1 of a fast pyrolysis biochar from the same greenwaste, the result is:

$$C:N = (3 \times 30 + 1 \times 50) / 4 = 35$$

This result is at the upper end of our 25 – 35 target range.

What about a more commercially attractive 50 volumes of greenwaste to 1 of fast pyrolysis Biochar from greenwaste?

$$C:N = (50 \times 30 + 1 \times 50) / 51 = 30.4$$

WHAT ABOUT P,K, S, Ca, Mg, Mn etc ?

These essential nutrients play key roles in plant nutrition, but a relatively minor role in composting. So, you want these in your mature compost, but these are not so much a prerequisite for composting.

The ideal N:P:K:S ratio varies considerably with different plants and environmental conditions, so general rules of thumb are not possible. For example, excessive P can be bad for plants adapted to poor soils (such as, desert plants and many Australian natives).

Thus, greenwaste and fast pyrolysis biochars from greenwaste can be co-composted over a very wide range of blend ratios (presuming the pH of the blend is suitable).

What if you don't want to add anything to adjust the C:N ratio in your biochar, but you still want to compost it? In the case of slow pyrolysis chars, forget it: they are too inert. It is possible to compost fast pyrolysis biochars without doing anything more than bringing the pH below 8, by leaching with rainwater or better still, a compost tea from a previous compost batch. Mixing some of the target soil is a good idea to help inoculate with local microbes. The other option is to blend freshly made biochar with water and then with an already well-composted biochar at no more than 1 part fresh biochar to 2 parts composted biochar. The composting process will be slower than a properly balanced blend, but it will happen.

Nutrient Suppression

Organic materials and biochars share a common characteristic. When first added to a soil, they suppress the nitrogen available to plants. For organic material, this is largely due to a surge in microbial activity in the presence of readily available organic carbon. For biochar, this effect is combined with—in fact, *dominated* by—chemical adsorption of nutrients into the char, which extends beyond just nitrogen to affect most nutrients (see sidebar). For this reason it is very unwise to add an unconditioned biochar directly to soil without adding compensating nutrients at the same time.

ADSORPTION PROPERTIES OF BIOCHARS

Adsorption is not strictly the same as ***ab***sorption, but either way it means that something is grabbed and held onto. For biochars this can extend to grabbing and thus reducing the effectiveness of chemicals like pesticides, fungicides, and herbicides. This is an important consideration for farm operations that use these chemicals.

Source of Starter Organisms

Most compost operations derive their starting material from either the naturally occurring microbes in the air and soil, or previous compost materials such as residual material left behind or compost teas (a liquid run-off from compost which can be collected or made). Many professional composters seed the compost with a proprietary starter mix. This will often accelerate the initial stages of composting, but scientific trials have reported mixed results in terms of the net financial value of this inoculation method, so it is best left to the professionals.

COMPOSTING METHOD

There are many methods for composting; these can be grouped as actively aerated (for example, turned windrows and drums) to passively aerated (piles and bins). In addition, there are anaerobic digestion and vermicomposting (using worms). Ultimately the choice comes down to the upfront and operating costs for a given circumstance. As a first approximation, the process suited to the biomass feedstock will be best.

The key principle for successfully inoculating biochars or soils with beneficial microbes is that the best results come from working with nature—rather than trying to force it. In simple terms, this means getting the pH, moisture and C:N ratio right and then inoculating with locally available microbes rather than exotic mixtures.

Composting is a great way to condition Biochars, however Biochars also provide many benefits to composting processes. The key benefits of Biochars in a composting situation are:

(a) Biochar (especially the larger particle fractions) aids the passage of gases, thus enhancing natural aeration processes.

(b) Biochar reduces the loss of nitrogen to the atmosphere, especially in the early stages of the process.

(c) Biochar aids in water retention.

(d) Biochar provides "micro-climate controlled" housing for the microbes to proliferate in, possibly speeding the composting process

pH (Acidity/Alkalinity, or Liming Effect)

As a general rule biochars have a liming effect—that is, they raise the soil pH. This effect is mild for chars from bark-free wood or sawdust. However, biochars from a source with a high inorganic content (for example, rice husks and grasses) will often have an unbuffered pH in the region of 8.5 – 10.5.

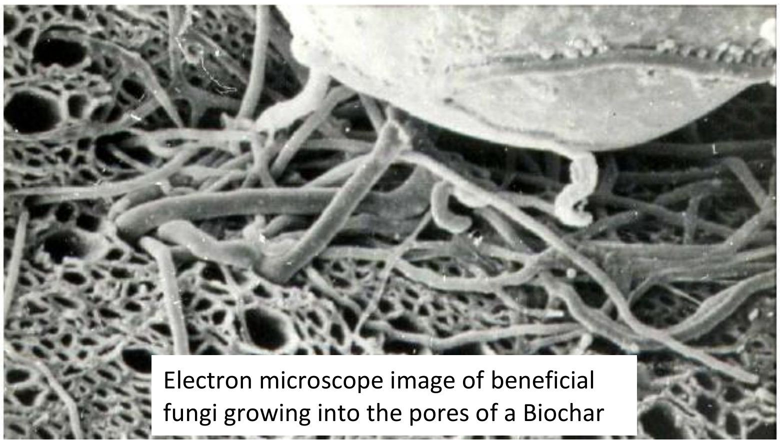
Similarly, fast pyrolysis biochars tend to have a lower unbuffered pH than slow pyrolysis biochars from the same feedstock. This is because fast pyrolysis biochars contain a higher residual organic carbon fraction, unless produced closer to the ash end of the biomass conversion scale.

The unbuffered pH of biochars can be moderated by blending with an organic ferment solution, or by blending into a starter compost mixture, as described previously. The exact ratio depends on economics, compost availability, C:N considerations, and the liming strength of the biochar.

ORGANIC FERMENT

An organic ferment solution is a mixture of a starch or sugar containing material (eg. molasses, ground up grains, ground up fruit of vegetable scraps etc.) which is mixed with 90% water and allowed to ferment for a few days or weeks. Technically the result is called a beer. This will have a pH in the range of 4.5 to 5.5, due to the formation of organic acids.

At the small scale, vinegar is an off-the-shelf organic acid that can be used to lower the pH of Biochar.



Electron microscope image of beneficial fungi growing into the pores of a Biochar

RECOMMENDATIONS FOR PREPARING BIOCHARS AND ADDING TO SOILS

The key principle for successfully conditioning biochars and then using them in soils is that the best results come from working with nature—rather than trying to force it. In simple terms this means ensuring that the condition of the mix is compatible with microbial growth. The essential specifications and target ranges are as follows:

Table 2. Recommended conditions for composting and soil addition

METRIC	SPECIFICATION/TARGET RANGE
pH	5.5 – 8.5 (ideally 6.5 - 7)
Temperature	20 – 40°C (ideally higher than 30°C)
Moisture	30 – 40wt% (the point at which some can be just squeezed out by hand)
Nutrients C:N	25:1 – 35:1 for composting 20:1 – 25:1 for direct soil inoculation, with due consideration of N:P:K:S ratios for the given crop
Char particle size	Mixed size range from fine dust to 5mm will provide scope for all of the physical and biochemical properties to be achieved.
Source organisms	From the local soil (if healthy), previous compost, or compost tea.

Can't I just dig it straight in ?

Biochar ***can*** be added to the soil without conditioning it first. But this is risky, because unconditioned biochar can cause a step change in moisture, pH, or nutrient availability, which the plants may not like.

This risk is minimized by conditioning the biochar before adding it to the soil.

The specifications and target ranges contained in Table 2, taken as a whole, represent the starting point for conditioning biochars. From this starting point, it will typically take 3 – 9 weeks in subtropical conditions for the material to mature enough to use it, with confidence, directly on plants. The composting process may not be fully complete for months. However, once a good level of microbial activity has been established, the product is suitable for addition to the soil.

Given all the above discussion about conditioning biochar before adding it to the soil, the natural question might be "Can't I just use biochar directly?" Yes you can, but if you use an unconditioned biochar, you are taking gamble that may or may not payoff. In some applications (for example, large-scale soil remediation) this risk is economically justified, but for commercial crops it is the equivalent of Russian Roulette until you have definitive proof that it won't upset the soil by causing a steep change in moisture, pH, or nutrient availability.

CONDITIONING BIGCHARS

The BiGchar process yields fast pyrolysis biochars, which are ideal for co-composting with other biomass. BiG typically composts Biochars from sugar cane trash and from mixed greenwaste.

The process used by BiG involves adjusting the water content to roughly 50% by mass then adjusting the pH adjustment by relaying on either simple using rain water leaching and/or the addition of organic ferment solutions, followed by natural decomposition in-situ in porous bulk bags, or covered stockpiles. The resulting product is a rich black earthy smelling soil like material with an unbuffered pH of approximately 8, which can be used at addition rates up to 100% with most plants, when in conjunction with moderate fertiliser addition.

Dunder, also known as Vinasse is a byproduct of the production of ethanol from sugarcane molasses or juice. It is the residue after fermentation.

Sometimes dunder is fortified for use as a "one shot" liquid fertiliser. For more details search for "CSR Ethanol Biodunder".

Dunder (or vinasse) from the local ethanol distillery has also been considered for use as a pH lowering agent, as this has a pH as low as 4 and provides additional nutrients such as nitrogen, phosphorous, potassium and sulphur. For pot and small garden trials the company has also used vinegar as a convenient pH lowering agent.

Worms – Canaries in the coal mine and mini-aerators

Worms in soil are like the proverbial canaries in the coal mine. If something is wrong they will move on (or in the worst case die).

Ideally worms should be added to compost blends after the initial period of maturation (i.e. once the internal temperature is below 34^{o}C). Worms will provide a clear indication as to the toxicity of the compost blend. If the worms cannot be found in the compost blend after a few days, then there is something wrong with it. Worms also help the composting process, by turning over and aerating the mixture.

BiGchar pot trials

The photographs shown on the following page were taken 27 days after planting of corn seeds (Mr Fothergill Early Extra Sweet Corn F1) in a range of soil blends, and 29 days after planting of tomato seeds. The control soil was a good quality, previously uncultivated, basaltic soil from Maleny, Queensland.

The Biochar used in the trials was prepared from mixed greenwaste using the BiGchar fast pyrolysis process and conditioned by a simple dampening and holding for approximately 3 weeks.

Pot 1 was prepared with only the control soil.

Pots 2 and 3 (not shown) were a blend of 2 and 5% char in the control soil with no fertiliser addition. These showed enhanced growth relative to the control plants but not as obviously as those pots pictured above.

Pot 4 contained the control soil only with 0.75% of a liquid NPK fertilizer added. On average these plants grew 11% higher than the control plants.

Pot 5 contained soil mixed with 0.74% of a common NPK fertilizer plus 2 wt% char. On average these plants grew 38% higher than the control plants

Pot 6 contained soil mixed with 0.68% of a common NPK fertilizer plus 5 w% char. On average these plants grew 41% higher than the control plants.

For the tomato trials equal doses of a soluble NPK fertilizer were added to all pots (including the control Pot 1) on Day 20. All except the three best plants in each pot were removed at day 24, to avoid overcrowding.

Selected plants from the Tomato trial

Pot 1 contained only the control soil.

Pot 2 contained soil mixed with 2.4% char. The plants grew 50% higher than the control.

Pot 3 contained soil mixed with 4.8% char. The plants grew 70% higher than the control.

Pot 4 contains soil mixed with 2.4% char and acidified with 2.4% white vinegar. The plants grew 37% higher than the control plants.

Pot 5 contains soil mixed with 4.6% char and acidified with 2.3% white vinegar. The plants were 77% higher than the control plants.

OTHER STUDIES AND TRIALS

The following examples of inoculating biochar are sourced primarily from the archives of the International Biochar Initiative website (www.biochar-international.org).

Composting with Rice Bran

Dr.Yoshizawa and his co-workers at the Meisei University, Japan described co-composting bamboo charcoal with rice bran as nutrient at a weight ratio of 1: 1.15. The mixture was adjusted to 65% moisture and then seeded with an aerobic microorganism complex. The mixture was maintained in ambient air at 23^{o}C stirred daily to aerate. Examination with a scanning electron microscope revealed that microorganisms had proliferated on surface and in the pores of the charcoal after as little as 70 hours.

The same team also described the successful routine composting of a mixture of 10% charcoal and garbage from 55 houses over a 2-month period in April and May of 2005 in the city of Suwa, Japan. Vigorous microbial growth was evident in and on the char when examined after 1– 2 months.

Co-inoculation of Soils with Compost and Biochar

Seattle BioChar Working Group (SeaChar.org) has been conducting plot trials since 2009 with co-treatments of biochar and manure. The results of these trials are still pending.

Inoculating Soil with Biochar and Compost

The Gabi Soto of the Center for Tropical Agriculture Research and Teaching in Costa Rica are using the Bokashi composting system with a sugarcane bagasse biochar to make a marketable fertilizer for organic farming. Bokashi is a commercial composting system that uses a commercial inoculum of microorganisms. In this case the microorganisms used are a mixture of the Bokashi commercial inoculum, augmented with local microbes sourced from forest leaf litter which had been fermented using a molasses substrate mixed with rice polishings. The compost blend is composted anaerobically for 10 to 15 days, then spread out and sprayed with the inoculant, then composted aerobically again for a period of approximately 20 days. The typical composition of the product is N 1.6%, P 1.4%, K 2.7%, organic material 32.3% (C:N of approximately 18:1). Soil application rates for the resulting product are 1.5 to 3 tonnes/hectare.

Experiments on Co-composting Poultry Litter with Biochar

Christoph Steiner and his co-workers at The University of Georgia have conducted experiments on the composting of poultry litter with 20% pine chip char biochar. The composting period was 42 days. The results indicated that the biochar increased the rate of composting, and reduced total N losses by up to 52%. Their conclusion of was that biochar may be an ideal bulking agent for composting N-rich materials.

Bruno O. Dias and his co-workers in Brazil and Spain evaluated the use of Eucalyptus wood biochar as bulking agent for the composting of poultry manure, against coffee husk and sawdust. They found that despite the inert nature of the biochar, the composting mixture prepared with biochar underwent a comparatively rapid organic matter degradation of 70% of the initial content. The biochar also reduced the losses of nitrogen.

CONCLUSION

This technical note introduced the concept of composting as a way to condition Biochars and ensure the benefits attributed to the biochar phenomenon. The adaption of composting concepts such as C:N ratio to the co-composting of biochars with other biomass was introduced. Recommendations were made to achieve successful microbial growth, with the need for special inoculant mixtures. Attention to pH, nutrient balance and moisture in the composting process were recommended as a way and ensuring a positive plant response on the addition of the conditioned biochar compost blend to the soil.

BiGchar™ … sometimes Black is Green