PREMIER'S CLIMATE CHANGE COUNCIL 2022 SA CLIMATE LEADERS AWARDS FINALIST

MACCY BIOCHAR MEMBER BULLETIN

No. 59 – 1 September 2024

Maccy Biochar is a Task Group of the Macclesfield Community Association Inc.
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67,701 litres biochar made; 33.14 tonnes of CO_2 removed.

Welcome to our 59th Member Bulletin. In this Bulletin please find our latest news items from here and further afield.

LOCAL NEWS:

Production Update:

Biochar production this season so far is 2540 litres, representing a carbon drawdown of about 1.05 tonnes of carbon dioxide from the atmosphere.

Biochar Basics Workshop & Demonstration:
– Sat. 10 August: Sponsored by AHRWMA

AHRWMA
Adelaide Hills Region Waste Management Authority

"Sustainable Waste Management Through Shared Services"

The second biochar workshop sponsored by the AHRWMA was held on Saturday 10 August at the Macclesfield Institute Supper Room and in the afternoon at a nearby property courtesy of Kelvin & Fiona Williams. The weather was perfect and hopefully the demonstration of making biochar removed any doubts that participants may have had about the effectiveness and simplicity of the process we use.

Kelvin minds the fire while others tour the garden

Checking the finished biochar

MCA AGM:

The Macclesfield Community Association will be holding its AGM from 7pm on Monday 9 September in the Macclesfield Institute followed by supper. All members of Maccy Biochar are entitled to attend.

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LAMEROO BIOCHAR WORKSHOP - 27 August:
Murraylands & Riverland Landscape Board Soil Extension Officer Barrie Williams presented another Workshop on biochar in agriculture at Lameroo with Maccy Biochar demonstrating the use of our biochar kiln. Kelvin, Fiona and Dennis attended and once again Kelvin got the job done.

BIOCHAR & SOIL pH – WHAT DO THE EXPERTS SAY?
As promised I have done a bit of research on this topic and am starting to come to grips with all the issues involved – and there are many. Soil science is amazing! All of the commentary below has been sourced from the internet but I have tried to simplify it and personalise it to make it a bit easier to digest under the following headings.

1. What is pH?
2. What causes acidity in soils?
3. What causes alkalinity in soils?
4. Why is biochar alkaline?
5. What happens when you add biochar to soil?
6. Does biochar increase the pH of soils?

1. What is pH?
The term pH and the pH scale from 0 to 14 were created by a Danish chemist called Sorenson in 1909 to provide a convenient way of expressing the degree of acidity or alkalinity of an aqueous solution.

When water (H_2O) is subjected to a difference in electric potential it will start to break down into positive H^+ ions and negative OH^- ions. A solution with an equal number of H^+ and OH^- ions is neutral. Sorensen chose a value of pH = 7 for such a case of pure neutral water. An acid solution will have more H^+ ions than OH^- ions and an alkaline solution will have less H^+ ions than OH^- ions.

So the acidity/alkalinity is determined by the quantity of positive hydrogen ions floating around in solution. The expression Sorensen came up with to describe the extent of H^+ ions in a solution was an inverse one. That means that the value of pH decreases as the number of H^+ ions increases and vice versa.

He also faced the problem that there are a heck of a lot of water molecules in a drop of water so there will be a very large variation in the number of H^+ ions from one end of the pH scale to the other (i.e. from 0 to 14). Actually there are about 30 sextillion molecules of water per millilitre.
(1 sextillion = 1,000,000,000,000,000,000,000.) So he chose a logarithmic scale (base 10) to describe the variation in pH with variations in the number of H^+ ions in solution.

He ended up defining pH as the negative logarithm (base 10) of the activity of H^+ ions in a solution.

So in terms of soil pH it is the negative logarithm (base 10) of the activity of H^+ ions in a slurry of the soil mixed with pure water.

2 What causes acidity in soils?
Rainfall: Average rainfall has a pH of 5.6 and is moderately acidic due to dissolved atmospheric carbon dioxide that combines with water to form carbonic acid. When this water flows through the soil it results in the leaching of base cations as bicarbonates; (the base cations are mainly calcium, magnesium, potassium and sodium being the primary nutrients sought by plants) and this leaching increases the percentage of Al^{+++} and H^+ ions relative to other cations.

Root respiration and decomposition of **organic matter** by microorganisms release CO_2 which increases the carbonic acid concentration and subsequent leaching.

Plant growth: Plants take up nutrients in the form of both cations and anions (negatively charged ions) and they often take up more cations than anions. But plants must maintain a neutral charge in their roots,

so in order to compensate for the extra positive charge they will release H^+ ions from the root. Some plants also exude organic acids into the soil to acidify the zone around their roots to help solubilize metal nutrients that are insoluble at neutral pH, such as iron (Fe).

Fertilizer use: Ammonium fertilizers react in the soil by the process of nitrification to form nitrates and in the process release H^+ ions.

Acid rain: The burning of fossil fuels releases oxides of sulphur and nitrogen into the atmosphere. These react with water in the atmosphere to form sulphuric and nitric acid in rain.

Weathering: Weathering can cause oxidation of some primary minerals, especially sulphides and those containing iron generate acidity. Acid sulphate soils formed naturally in waterlogged coastal and estuarine environments can become highly acidic when drained or excavated.

3. What causes alkalinity in soils?

Total soil alkalinity can increase with:

Weathering of silicate, aluminosilicate and carbonate minerals containing Na^+ , Ca^{++}, Mg^{++} and K^+;

Addition of silicate, aluminosilicate and carbonate minerals to soils; this may happen by deposition of material eroded elsewhere by wind or water, or by mixing of the soil with less weathered material (such as the addition of limestone to acid soils); so the concentration of H^+ ions is thereby reduced and so the pH increases.

The accumulation of alkalinity in a soil (as carbonates and bicarbonates of Na, K, Ca and Mg) can also occur when there is **insufficient water** flowing through the soils to leach soluble salts. This may be due to arid conditions, or poor internal soil drainage; in these situations most of the water that enters the soil is transpired (taken up by plants) or evaporates, rather than flowing through the soil.

By the way we all know that over millennia plant communities have evolved so as to thrive in whatever soils they have (except for complete deserts) so pH is not a problem in Nature. It only becomes a problem for us when we try to grow plants in soils that are unsuitable for those types of plants. But we want them anyway and we have been incredibly successful in doing so. But at what cost to the soils we have mined? Because that's what agriculture has become – an extractive industry.

4. Why is biochar alkaline?

Because it contains alkaline organic functional groups and base cations. These base cations originate in the soil and are taken up by the plant from which the biochar is ultimately made. When wood is completely burnt all that remains is ash. The ash is made up of these minerals that were originally in the soil where the plant grew. When we pyrolyse wood some of the minerals remain in the biochar. Typically the amount of these minerals that remain in the biochar is about 10% by weight. We know this from the analysis we do on the biochar to determine its content. The analysis involves burning all the char and measuring the weight of the ash that remains. That ash was the mineral content of the biochar.

So when we crush some biochar and add pure water to make a slurry and measure the pH of that slurry it should be alkaline. Of course the biochar can be rendered neutral or even acidic by quenching it or rinsing it in a slightly acidic solution.

5. What happens when you add biochar to soil?

A lot of factors influence the outcome. They include: the particle size of the biochar; the pH of the biochar; the application rate of biochar to the soil; and perhaps most importantly: the nature of the soil itself.

Soils exhibit a buffering action. This action buffers soils against changes in pH when acid (H_2SO_4) or base ($CaCO_3$) is added. This resistance to change can be demonstrated by comparing the titration curves for pure water with those for various soils (See Figure below).

Most soils are highly buffered at low pH by the hydrolysis and precipitation of aluminium compounds and at high pH by the precipitation and dissociation of calcium carbonate. But most of the buffering at intermediate pH levels (pH 4.5–7.5) is maintained by cation exchange and the gain or loss of H^+ ions of pH-dependent exchange sites on clay and humus colloids. In the graph below the well-buffered soil (C) would likely have a higher content of organic matter and/or

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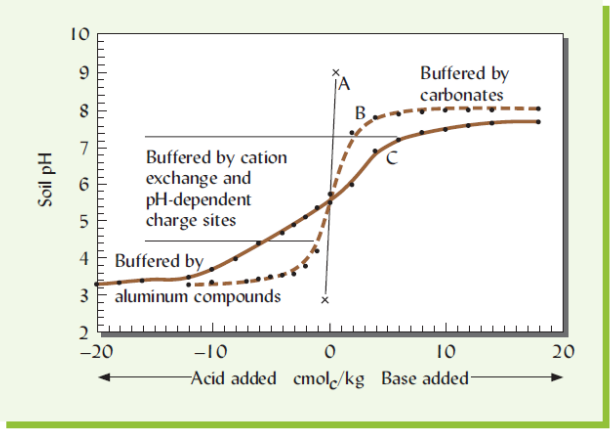
more highly charged clay than the moderately buffered soil (B).



Buffering is demonstrated by Comparing Titration Curves for Pure Water with Those for Various Soils. Source: The Nature and Properties of Soils Fifteenth edition by Ray R. Weil & Nyle C. Brady.

Soil buffering depends on several factors:

1. Clay content and type (texture)
2. Organic matter content
3. Oxide components
4. Carbonate content
5. Initial pH
6. Weatherable mineral content

6. Does biochar increase the pH of soils?

Hopefully you will now be able to answer that question yourself in the affirmative but qualify it by an appreciation of the many factors that govern the extent to which soil pH may or may not permanently increase after the addition of biochar.

Personally I think that the advantages of adding biochar to the soil are less to do with altering soil pH and more to do with increasing water holding capacity, providing more negatively charged surfaces for cations to swap with (cation exchange capacity) and providing free board and lodging for soil biota.

If you really must alter the pH of your soil by a significant amount then using lime (for acid soils) or sulphur (for alkaline soils) will be far more effective than using biochar. But whenever biochar is intended to be used on a large scale it's important to first carry out representative soil sampling to determine soil pH; total organic matter; and nutrient availability; etc.

The NSW Department of Primary Industries has a brief but straightforward description of cation exchange capacity and related topics at:
https://www.dpi.nsw.gov.au/agriculture/soils/guides/soil-nutrients-and-fertilisers/cec

And another very good article can be found at:
https://www.biocycle.net/soil-chemistry-and-the-quality-of-humus/

Finally let me say just this:
As impressive as our knowledge of soils is, it can only ever be that of the observer; and inevitably the observer influences the behaviour of the life it observes. We can never fully understand the intricacies of soil life communities because unless you are a cation or an anion you will never be subjected to the forces abounding in the soil world. There are millions of ions swarming around in the soil soup looking for an oppositely charged ion or surface to couple up with. Do the base cations get pushed off their perches on the negatively charged surfaces of soil and biochar particles by the H^+ ions by sheer weight of numbers? Or are they looking for an opportunity to get back into the soup and do some mingling?

I hope all of the above has whetted your appetite to learn more about what makes our soils thrive and by doing so help us to thrive. And by all means call me out on anything I may have written that you know is incorrect or misleading.

COMMITTEE MEETINGS

Committee meetings are normally held on the 3rd Monday of the month (public holidays excepted) from 7:30 pm. in the Macclesfield Institute Supper Room. You are invited to come along if you have a biochar matter you would like to discuss or simply to meet us.
Next meeting: Monday 16 September 2024.

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