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An Emerging Valuable Soil Amendment "Biochar"

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Abstract

Biochar, a carbon rich product has caught attention due to its high carbon (C) content and porous structure. Biochar application to soil have so far focused mainly on the agronomic benefits. It can be applied to the soils for improving soil health, fertility, and carbon sequestration. However, further research is needed for recommending biochar application on a large scale to improve crop yields. It is known for positively influencing different soil processes which in turn will enhance soil physical and chemical and biological properties improving nitrogen fixation, decreasing leaching of nitrate and emission of N_2O emission.

Keywords: Amendment, Biochar, Carbon, Sequestration, Leaching

Biochar is a highly porous, stable, carbon-rich material produced from thermal decomposition of biomass (grass, agricultural and forest residues) at higher temperatures without or with limited supply of oxygen. The word 'biochar' is derived from the Greek word 'bios' meaning life and 'char' meaning charcoal. During the process, a mixture of solids, liquid and gas products are formed. The yields depend on parameters such as, residence time, temperature and heating rate which can be adjusted for preparing either biochar or energy. Biochar preparation requires an ideal temperature of 400 – 500 °C, while liquid and gas fuel components are produced above 700 °C. This practice involves conversion of agricultural waste into a soil enhancer which can hold carbon, boost food security, increase soil biodiversity and discourage deforestation. Intensive studies of biochar-rich dark earths in the Amazon (terra preta), has led to a wider appreciation of biochar's unique properties as a soil enhancer. It has the potential for addressing climate change. However, research concerning this issue is still being carried out.

Figure 1. Biochar and result of its application in beetroot crop

How Biochar can be used?

Biochar can be used in following ways:

1. **CARBON SINK:** Large amounts of carbon dioxide and methane is released into the Earth's atmosphere during the natural decomposition of biomass. Similar elements are released into the atmosphere by biochar decomposition, but comparatively the carbon content is more stable. It provides for suitable storage of carbon in the soil, potentially reducing greenhouse gases (GHG) in the atmosphere thus increasing soil fertility and agricultural productivity at the same time.
2. **SOIL AMENDMENT:** It is a highly porous material ideal for enriching soils by retaining both water and water-soluble nutrients. It is capable of improving water quality, reducing nutrient depletion, soil acidity and irrigation and fertilizer requirements.
3. **WATER RETENTION:** Biochar is hygroscopic in nature thus capable of absorbing and holding water from the surrounding environment. Thus , ideal soil material in areas of water scarcity. Also, nutrients such as phosphate and nitrogen are retained reducing the requirements of fertilizers.
4. **SOIL CONDITIONER**: Biochar is a perfect soil conditioner for improving several soil physical, chemical and biological properties. It influences the growth, composition, and activity of soil biota. Due to its porous structure, high water holding capacity and large surface area, it provides a suitable habitat for soil biota.

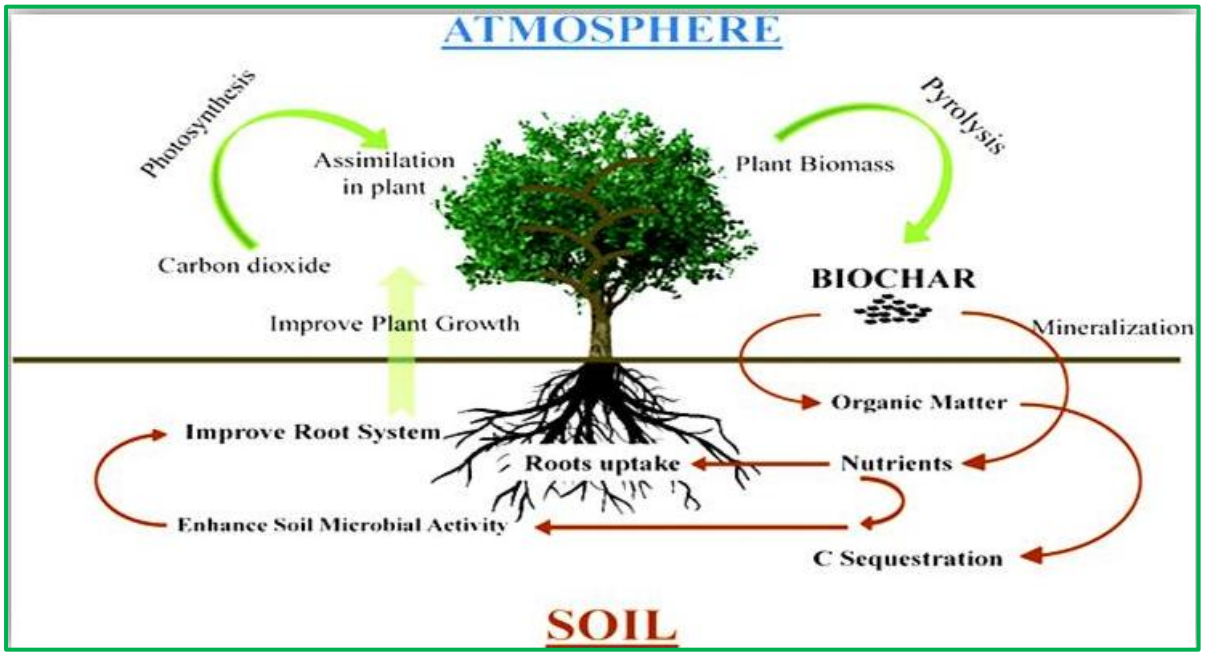

Figure 2. Systematic recycle of biochar in the environment

Biochar as a tool to Combat Climate Change

The carbon in biochar is more stable form which resists degradation (**Lovins *et al.* 2011**). In addition to biochar, certain oil and gaseous byproducts are produced during the process which can be used as fuel, providing clean and renewable energy. It retains up to 50% of its initial carbon content compared to 3% in traditional burning and 10 – 20 % via decomposition (**Lehmann *et al.* 2006**). Biochar and bioenergy co-production can be used for mitigating climate change effects by displacing fossil fuel use and by sequestering carbon in stable soil carbon pools. However, it is can be seen as an effective solution to climate change only if it remains stable in the soil for many years. Otherwise, decomposition will lead to the return of its stored carbon back to the atmosphere.

Limitations of biochar application

Biochar can improve soil physical properties; however, this is often soil specific. Incorrect application of biochar leads to increased problems of wind erosion. Black carbon produced during biochar production can have toxic effects on human and environment. It leads to global warming impacts and risk of lung and heart disease (**Danielle *et al.* 2009**). Though, currently little research evidences are available relating to biochar black carbon impacts. Due to its high sorption nature, sequsteration of pesticides is also known to occur with biochar application. Besides, having beneficial roles in reducing leaching of chemicals, it could also reduce their general effectiveness leading to over applications and increased crop losses associated with soil-borne pathogens and other pest impacts.

Conclusion

Biochar has drawn a great attention worldwide in terms of it several benefits from agronomical point of view. It can play a vital role in enhancing soil's physical, chemical and biological properties thus making it more productive and healthy. However, little research, mainly focused on improving crop yields, has been done on biochar application. It can be a great solution for reducing emission of green house gases and combating climate changes. Thus, more research yet to be done for exploring its different benefits in various other aspects.

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