Biochar: The Black Gold for Enriching Agriculture

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Abstract

Biochar, often referred to as "black gold," stands at the forefront of sustainable agricultural practices, offering a transformative solution for enhancing soil health and crop productivity. This study delves into the multifaceted role of biochar in enriching agriculture value. By meticulously exploring its impact on soil structure, nutrient retention and microbial activity, we unveil the intricate mechanisms through which biochar contributes to the overall health of agricultural ecosystems. Furthermore, this article highlights the potential economic benefits and environmental advantages of integrating biochar into farming practices, emphasizing its pivotal role as a valuable resource in the pursuit of sustainable and resilient agriculture. As we navigate the complexities of modern agriculture, biochar emerges as a promising avenue for cultivating prosperity and resilience in the fields, truly earning its status as the black gold of agriculture.

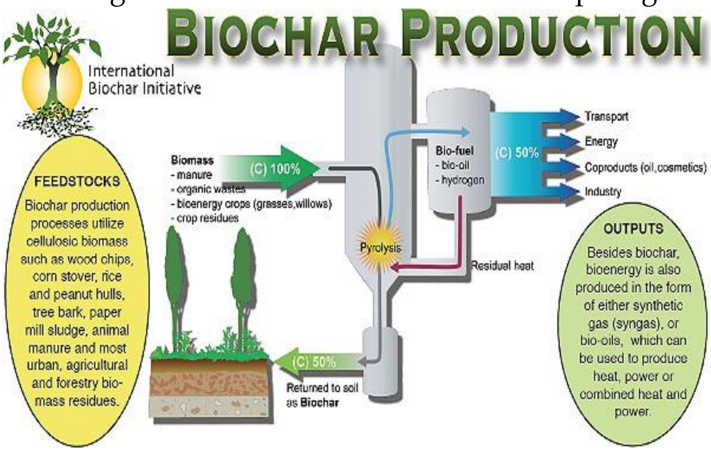
Introduction

Biochar is granular material obtained by heating crop residue at 400°C to 600°C in a kiln-shaped structure in the absence of oxygen. It is used as fertilizer to improve soil health and water-holding capacity of agriculture land. India is the second-largest agro-based economy wherein crop cultivation is taken all around the year, producing a large amount of agricultural waste, including the crop residue otherwise the stubbles. The prime means of disposing of the stubbles, in North India, is being the stubble burning that has popped out as a major issue of environment issue, severely affecting the air quality. This steers to serious health threats and ultimately global warming. Though the GOI had sought to restrict this problem through various measures and campaigns to promote sustainable stubble management, the issue is not yet under control rather alarming rise in air pollution added by the stubble burning is the only result. The burning of stubbles causes various ill effects that are deleterious to human health, soil health, soil-dwelling organisms, ecosystem, and environment.

Biochar can serve as a potential ingredient to remediate the problem caused by the stubble burning. There are many reports available presenting the scope of biochar in improving soil nutrient status, plant productivity and mitigation of greenhouse gases and are discussed in this section. Biochar is a charred, organic, solid, porous, fine-grained, carbon-rich product obtained from the thermochemical conversion, called pyrolysis, under the condition of low or no oxygen. It is a material of comparably higher carbon content than that of its parent material, high stability and surface area of 0.5-450 $m^2 g^{-1}$. It is reported to contain nutrients such as phosphorus, potassium, calcium, magnesium and micronutrients namely copper, iron, manganese and zinc. The carbon, nitrogen content and the carbon-nitrogen ratio of biochar ranged from 33.0 to 82.7 per cent, 0.10 to 6.0 per cent and 19 to 221, respectively. The biochar can be used as a soil amendment that has been reported to improve soil water, nutrient retention, soil surface area, earthworm and beneficial microorganism population.

What is Biochar and why the hype?

Biochar is charcoal made up of biomass with the process of pyrolysis. Biochar in absence of oxygen can be made from any biological material that used to be alive like logs of wood, bones, sunflower stalks, sugarcane bagasse, rice husk, corn stover, *etc* at around 300-700 Degree Celsius. Every bit of the materials containing cellulose, lignin, and other non-carbon materials vaporize and are consumed with extreme heat leaving behind a porous black structure that makes a clinking sound when smashed or brushed against each other. This left behind black mass possesses a great capacity to reduce the environmental impact of global warming by capturing harmful carbon-dioxide gas. Most areas where Biochar can be made use of is in and as activated carbon helping sequester carbon and nutrients in agriculture. Although Biochar has received quite recognition in recent decades it is, however, quite an old concept. The very first shreds of evidence of the use of Biochar are from the Pre-Colombian era by the Amazonians by burning agricultural wastes in pits or kilns and adding it soil. It is commonly known as Terra Preta (roughly translated into black soil) as most of the tropical soil is poor in nutrients and minerals which is only suitable for the growth of rich rainforests with help of good



sunlight as well as a prosperous amount of rainfall which had led to Amazonians developing the man-made fertile soil with help of Bio-char. Recently, Biochar has been widely used as a versatile material for various applications in agriculture and environmental allied sectors. It has proved to be an effective tool to economically sequester carbon, minimize waste production, and escalate the performance in the circular economy. Its unique

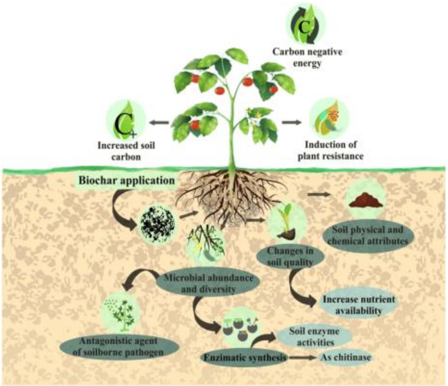
property to lock carbon for hundreds of years is what makes it so valuable and useful. Every year we burn a billion tonnes of biomass be it in form of crop residues, fallen/damaged trees, etc. which produces an intense amount of smoke containing various greenhouse gases such as methane, nitrous oxide along with carbon dioxide and Sulphur oxide which harms our planet as well as our lungs. If instead of open burning, we use this waste in process of making Biochar it will hardly produce any kind of smoke in comparison to when it wreaked havoc whilst open burning. Every year around winter we face intense pollution with a heavy amount of smog-causing difficulty invisibility as well as breathing farmers can easily adapt the process of making Biochar out of the crop waste it will prove to be beneficial for both farmers as well as environment.

Benefits of biochar to the soil

As a soil amendment, biochar alters the soil surface area, bulk density, pore distribution and water holding capacity adsorb both organic and inorganic contaminants and reduce nutrient leaching. It serves as a slow releasing reservoir of nutrients in the soil. The combined application of biochar and compost had reported increased activities of β-glucosidase, FDA hydrolysis and doubled activities of soil alkali phosphatase, protease, and enzymes involved in carbon, nitrogen and phosphorous cycles. As the soil extracellular enzymes are the proximate agents of organic matter decomposition and nutrient cycling, the increased activities of the above enzymes promote the soil nutrient status. It was reported that the blended application of biochar, compost and fertilizer increased the soil N-NH4, N-NO_3, P and K to 1.3, 1.8, 1.3, 1.7 folds, respectively.

Benefits of biochar to the plants

In general, the biochar application (exclusive or with compost and fertilizers) to the soil showed numerous positive effects on various plant metabolisms through which increased yields in various crops. Such effects of biochar on the plants were illustrated as a review concerning the vegetable crops. The usage of biochar in the vegetable crops is comparably lower and the vantages of biochar can be explored to maximize the growth and yield of vegetable crops. An increase in the plant available water (PAW) in watermelon and cowpea was noticed which was attributed by the improved available soil moisture (ASM) brought in by the biochar application at 25 t ha^{-1} at a depth of 10 cm. In lettuce, improved leaf traits such as increased number of leaves $plant^{-1}$, length, width and area of leaves were found with combined application of biochar and compost to the unfertilized soil. The total plant biomass increased in cowpea with biochar application at 25 t ha^{-1} at a depth of 10 cm, which was due to improved tap root growth and uptake of water from fine biochar pores. Similarly, an increase in the plant dry weight was reported in lettuce with the exclusive application of biochar. The increased yield with the biochar application in various crops is apparently due to the improved soil fertility and water retention.



Conclusion

Biochar integration in farming enhances crop yields, soil structure, and fertility, positively impacting microbial communities and nutrient retention for lasting benefits in agricultural ecosystems. Amid the challenge of feeding a growing global population and environmental concerns, biochar emerges as a vital force in promoting sustainable agriculture. Its economic advantages, including carbon sequestration, reduced reliance on chemical fertilizers, and improved water retention, highlight its overall cost-effectiveness. Biochar transcends being a mere agricultural amendment, acting as a transformative agent that rejuvenates and enriches the foundation of agriculture. Continued research, education, and widespread adoption are crucial for unlocking biochar's full potential, ensuring a resilient and prosperous agricultural future.

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