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Biochar: A boon for vegetables

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Biochar is the pyrolyzed product made by thermal degradation of organic materials in the absence of oxygen and is distinguished from charcoal by its use as a soil amendment. Over the past few years, much attention has received from researchers towards this pyrolyzed organic carbon because of the possible benefits arising to soil quality and crop yields. The idea to use biochar as an soil amendment comes from Amazonian terra preta soils. These soils are generally known for their high levels of fertility as compared to the adjacent soils where no organic C addition occurs.

Why to use biochar : Throughout the world the Agricultural waste is usually handled as a liability, often because the means to transform it into an asset is lacking. Here biochar plays very significant role in converting this liability to auseful asset. Residue burning traditionally provides a fast way to clear the agricultural field of residual biomass and facilitating further land preparation and planting. But the burning of crop residue on the field may cause many problems related to land and environment. In India, about 93 million tons of crop residues are burned each year primarily to clear the fields from straw and stubble after the harvest of preceding crop (rice and wheat system) that leads to cause pollution. As India has high potential to generate crop residues so why not we use these crop residues for making of biochar and give it to the soil as an amendment. Biochar is claimed to have several potential benefits, including Carbon sequestration, bioenergy generation, reduction of nitrous oxide (N_2O) emissions from agricultural soil, stimulation of soil microbial activity, sorption of pesticides and nutrient ions, improvement in soil structure and retention of soil moisture and control of soilborne diseases as reviewed in many studies on biochar.

Making of biochar: It has been observed from the long human history that formation of biochar from the woods (carbonation) has been practiced and is old as civilization itself. Amazonian soils are one of the examples of this. The technology used in biochar production ranges from simple soil pits to sophisticated industrial plants.There are many technologies for making this pyrolyzed product but as we know that India is a developing country so to make biochar technology popular among the farmers, it is important to develop low cost biochar kiln at community level or low cost biochar stove at individual farmer's family level. Some low cost technologies are like heap method, drum method, biochar stove method. On the other hand if the farmers are not willing to made biochar some companies also provide biochar to them. India has large potential to produce the crop residue biomass. So there is a need to establish the setup of chain between these companies and the farmers. This will also help the farmers at economic level to some extent.

Properties of biochar: It is a fine-grained, carbon-rich, porous product remaining after plant biomass has been subjected to pyrolysis process at temperatures 350–600°C in an environment with little or no oxygen.It is carbon negative in nature called black gold of agriculture. Biochar is more persistent than any form of organic matter. Studies have indicated that the carbon in biochar remains stable for million of years. Biochar has immense surface area and complex pore structural (a single gram can have a surface area of over 1000 square yards) properties in it.

Effect of biochar: Biochar is helpful for maintaining the different soil properties as well as also helpful for the environment through many ways as discussed below:

Soil physical properties: Biochar is porous in nature and when it is applied to the soil it will leads to Enhanced soil water-holding capacity, improved soil water permeability, improve hydraulic conductivity, reduced soil strength, modification in soil bulk density, modified aggregate stability and some other physical properties related to soil.

Soil chemical properties: Biochar reduces soil acidity by increasing pH (also called the liming effect), helps soil to retain nutrients and fertilizers, prevent fertilizer runoff and leaching, mitigates the impact of hazardous pesticides andfertilizers, absorbs complex fertilizers and pesticides in soil thus lessening their impact. Biochar can potentially increase the cation exchange capacity (CEC) of soils.

The application of biochar improves soil fertility via two mechanisms one by adding nutrients to the soil and other by retaining nutrients from other sources including nutrients from the soil itself.

Soil biological properties: With the addition of biochar there is a growing body of knowledge showing to increase the microbial biomass with significant changes in microbial community structure and enzyme activities .Biochar could influence mycorrhizal abundance. It increases soil microbial respiration by creating space for soil microbes and also have indirect effects on mycorrhizae through effects on other soil microbes.

Helpful for environment: The greenhouse gas effect is the cause of climate change and the most important greenhouse gas is carbon dioxide, long-term storage of carbon in soil is considered an important option to mitigate the increasing level of CO_2 in the atmosphere and biochar helps in it. Biochar has been also shown to reduce the amount of methane (CH_4) released from agricultural fields that utilize cover crops as a nutrient supply. According to a new study, as much as 12 per cent of the world's human-caused greenhouse gas emissions could be sustainably offset by producing biochar. One tonne of biochar is equivalent to 2.7 tonns of carbon dioxide removed from the atmosphere. The World Bank has identified biochar as the most effective system of greenhouse gas abatement in soil when compared to all other sustainable land management practices.

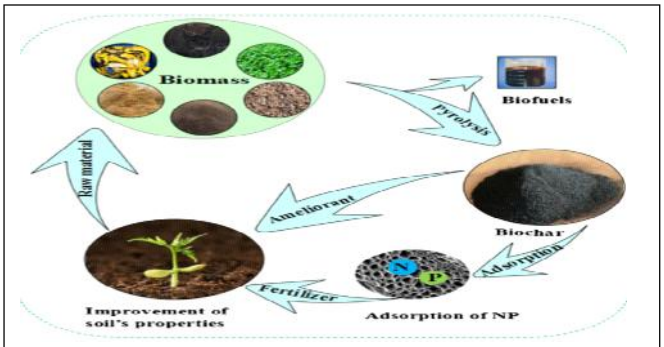

Fig. 1: Benefits of biochar applied as a tool for soil fertility management (Ding *et al.*, 2016)

Role of biochar in vegetables: Eating vegetables provides many health benefits like vegetables provide vital nutrients for good health and maintenance of the body. Most of the vegetables are generally low in fat and calories and is important source many nutrients which are useful for the proper body growth. Eating diet rich in vegetables as part of an overall healthy diet may reduce the many heart related disease, obesity, type 2 diabetes, lower blood pressure and reduce the risk of kidney stones etc. But now-a-days the quality of the vegetables become low.

It was found that biochar showed the positive results in the quality of vegetables also. William and Qureshi (2015) reported that plant height and leave count of okra grown in soil with biochar are higher than plants grown in soil without biochar in outdoor as well as greenhouse condition. Plant height or leave count is an important factor to analyze growth and health of vegetables. Carter *et al.* (2013) reported that due to the incorporation of biochar in the soil, the above ground biomass, below ground biomass, number of leaves, stem length is improved in lettuce plant. Jia *et al.*(2012) reported that by adding biochar with manure and urea the yield of vegetable is increased. Chan *et al.* (2007) reported that there is significant increase in the yield of radish (*Raphanus sativus* var. *long scarlet*) with increasing rates of biochar application in the presence of N fertilizer, indicating a positive role of biochar in improving N fertilizer use efficiency of the plant.

Conclusion: The application of biochar with different nutrient sources will lead to increase the yield and quality of the vegetables. It reduces the ill effect of the chemicals on the health of the human as it act as a purifier in soil and also making of biochar with crop residues will reduce many soil and environment related issues.

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