BIOCHAR FOR A SUSTAINABLE FUTURE

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Abstract

Biochar is a charcoal which is used as a soil amend. It is made up of wood, bones and other organic substances including the dried manure which is produced by a process known as pyrolysis under lower oxygen amount. Biochar can be used to improve the fertility of the soil which results finally increasing the crop yield. It has a honey comb like structure which will help in the increase of the water holding capacity, nutrient retention as well as by stopping the soil particles getting compacted with each other. Infertility in the soil occurs due to the addition of different types of pesticides, weedicides as well as lot of chemical substances. Therefore, biochar can act as a promising solution for the infertility of the soil while indirectly increasing the crop yield.

Keywords: Biochar, pyrolysis, infertility, aeration, charcoal

Introduction

The use of biochar is now being studied as a way to improve soil quality and fertility for agricultural yield, to provide ecosystem services such as the immobilization and transformation of pollutants, and to mitigate climate change by sequestering carbon (Bashagaluke et al. 2019). Carbon-rich biochar is produced by heating feedstock in a confined container with little or no oxygen accessible. There are a wide variety of feedstock's for biochar synthesis, including wood, organic and industrial wastes, and plant-based materials (e.g., leaves, husks, seeds, cobs). Due to changes in feedstock and pyrolysis characteristics (temperature, speed, duration), not all biochars are created equal (Fonseca et al. 2020). Experimental research shows that biochar application modifies soil characteristics in addition to carbon sequestration. When using biochar, soil qualities might be affected by its different features. It has been shown that adding biochar to soil increases soil pH, cation exchange capacity and the quantity of extractable minerals including Na, K, Ca and Mg. These improvements are advantageous to nutrient retention and fertility in soil. Additional modifications to soil microbial communities and activities, such as carbon mineralization and nutrient transformation, could result with the addition of biochar. For example, bulk density and physical conditions for plant development are improved by biochar in addition to soil chemical and biological qualities (Jing et al. 2020). This study focused mostly on soil water content changes. To maximize crop yields, soil water retention is essential. This is because plant water absorption and transport are directly influenced by soil water retention, and vice versa. Soil water retention may be affected by biochar application due to its high porosity, hydrophilic domains, and large specific outer area, have been shown in experiments to influence soil water retention. This effect is likely due to these factors (Lebrun et al. 2020). Experiments using diverse biochar properties, soil types, experimental settings, and durations might produce wildly varying outcomes, which makes it difficult to compare the findings between research and extrapolate the findings to new contexts (Li et al. 2019). The degree to which biochar alters soil water retention qualities is also a subject of substantial debate despite the quantity of research on the subject of biochar-soil interaction.

Methodology

The methodology of making biochar is a simple method done by using a technique called as pyrolysis in a lower amount of oxygen level. A pit was dug on the ground. Dried wood, dried plant materials, bones etc. were added into it. They were burned at a very high temperature by reducing the amount of oxygen. When it is burning, by observing the smoke, we can predict what is burning inside, for instance: - If the flame is white in color that means it is water vapor. If the flame is yellow in color, that will show the burning of resins and sugars. If it turns grayish blue and when the smoke becomes thin, make sure to cover it with little amount of soil to lower the air supply and leave it for few hours (Maroušek et al. 2019). After that, the organic matter is smoldered into the charcoal chunks, and then put some amount of water onto the fire.

Inoculation of biochar

The biochar which was prepared by using the above method was obtained. After that few amounts of nutrient was added onto it. Powdered sea weed as well as molasses too were added on it and was mixed it very well. Molasses will act as food for the microorganisms and it will encourage the microbes to populate. It was kept for about a week and after that, the biochar was mixed with the chicken stool. This will help to break down the oil in the biochar into very small particles (Figure 1). The above mixture was kept for about 3-4 months and after that, it was ready to put into the crops.

Liquid activation of biochar

The biochar which was prepared by the earlier steps was taken. Few amounts of water was added onto it in order to moisten it. A little amount of pressure was added on to it where the water does not come on to the surface of biochar. The water was filtered carefully. Now the water will help to soak all the nutrients and minerals that are present in biochar. After that, it was kept for 3-4 hours. Next, it was dried well and it was mixed with active biochar along with the rest of the minerals. Now the biochar is ready for the usage.

Result and Discussion

Soil Activation

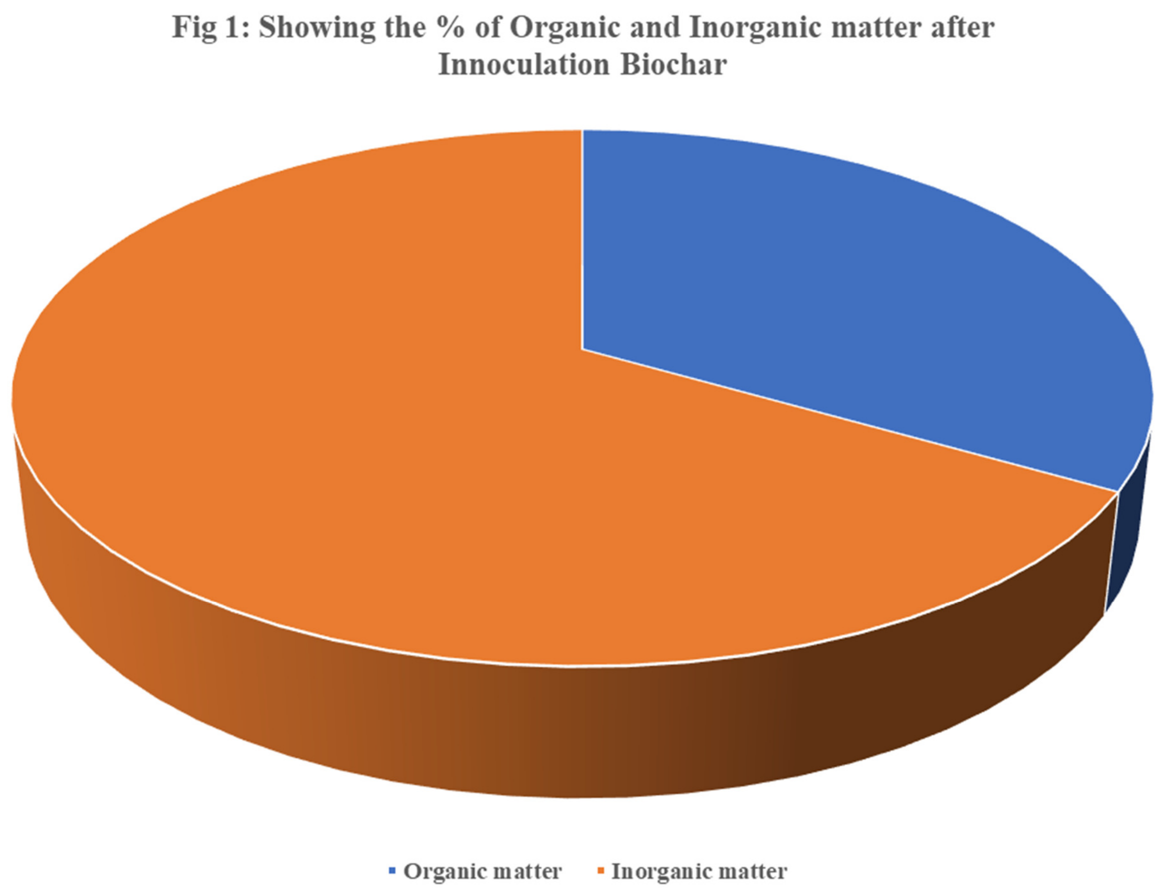
Soil dissolved organic matter is not greatly affected by biochar, throughout the data collected; however, soil microbial biomass is significantly increased by 12 percent. Biochar has a large impact on soil NH_4^+ and NO_3^- concentrations, with corresponding percentage changes by -6 percent (Pajouhesh et al. 2020). There has been a 28 percent increase in soil microbial biomass due to biochar, in accordance with prior meta-analyses of 16 research. Soil microbes involved in soil nitrogen cycling respond well to the addition of biochar to the soil. Because of its fine porous structure, high outer area, hydrophilicity, and mineral nutritional value, biochar provides a better environment for bacterial growth and development in soil (Wang et al. 2020). A lack of extractable inorganic nitrogen and refractory organic nitrogen in biochar make it an ineffective source of readily accessible nitrogen. In the presence of biochar, soil nitrogen availability is reduced, which may be due to high soil inorganic nitrogen absorption, high plant nitrogen absorption, and high soil ammonia volatilization loss.

Absorption of nitrogen by plants

Biochar increases plant nitrogen absorption by an aggregate of 11 percent, resulting from a 12 percent increase in plant biomass and a 2% decrease in percentage of nitrogen plant tissue. In acidic soils, biochar tends to boost plant biomass and nitrogen absorption, while it has minimal impact in neutral or alkaline soils (Wang et al. 2020). Therefore, biochar has the greatest influence on plant biomass and nitrogen absorption in soils with weak structure. Manure biochar has a greater effect on plant growth and nitrogen absorption than either wood or straw biochars (Ye et al. 2020). Over-application of biochar may greatly decrease plant biomass and nitrogen absorption, and the connection between biochar application rate and plant biomass or nitrogen absorption forms a convex curve. Several processes are responsible for the increased plant production and absorption of nitrogen caused by biochar (Zhao et al. 2020). Soil pH might be raised to a more neutral level with the help of biochar, hence reducing the dangers of Al_3^+ toxicity in even the most acidic soils. Soil tensile strength may be reduced and water retaining capacity can be improved by biochar, which is especially useful in soils with weak structure for root growth and water absorption (Figure 2). Because biochar has a high outer area that includes a certain quantity of negatively charged functional groups, it may increase soil organic matter content (Zhao et al. 2020). Finally, biochar provides a readily accessible supply of phosphorus, potassium, calcium, and magnesium, which may improve soil productivity and plant sustenance. In terms of plant development and nitrogen absorption, manure biochar is more helpful than other biochars because of its increased mineral nutrient concentration. Phytotoxicity may develop if the biochar application rate exceeds the optimal level for plant growth and nitrogen absorption, due to high soluble salts or a damaged soil aggregate structure.

Volatilization of Ammonia in the soil

19 percent of studies found that biochar substantially increased in the volatilization of ammonia from soil. Biochar has a greater influence on soil ammonia volatilization in acidic soils than in mildly acidic soils, but it has no impact on neutral or alkaline soils. Biochar is more likely to induce ammonia volatilization in clay-textured soils than in other soil type (Figure 3). When it comes to volatilization of ammonia in the soil, biochar species have a two-way effect: manure and straw-derived biochars increase it by 43 percent and 27 percent, respectively, whereas wood-derived biochars lower it by 30 percent on average.



Note: After inoculation of biomass, there was increase (blue) in the organic matter and the decrease (orange) in inorganic matter.

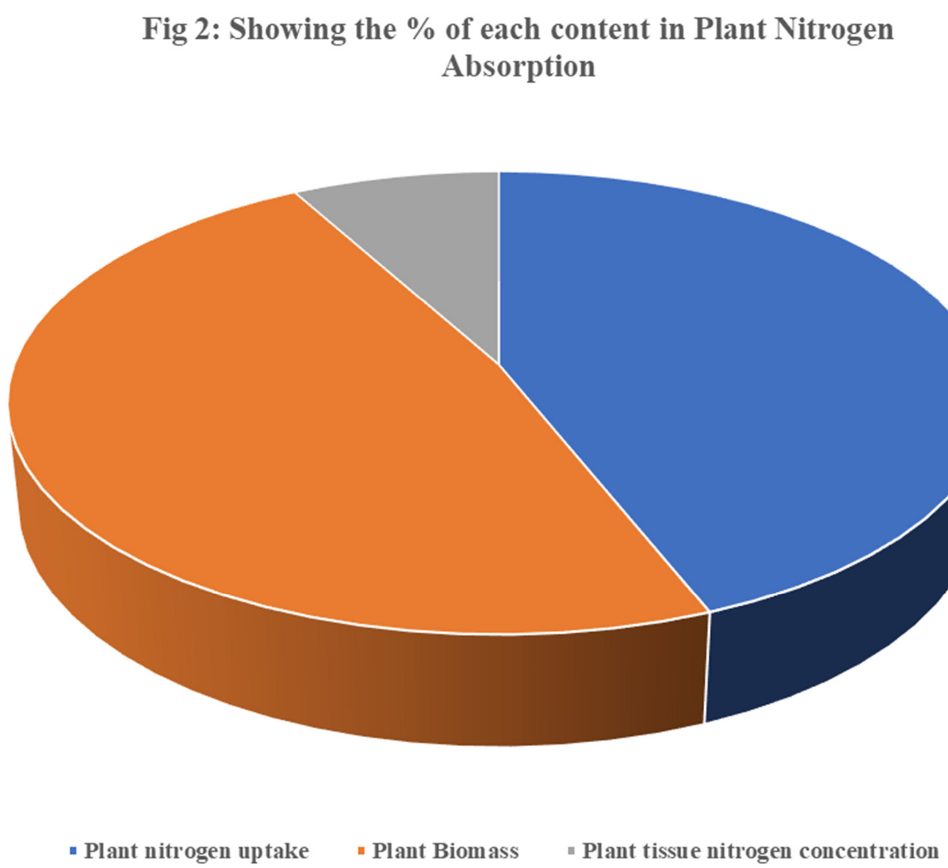


Fig 2: Showing the % of each content in Plant Nitrogen Absorption
Plant nitrogen uptake
Plant Biomass
Plant tissue nitrogen concentration

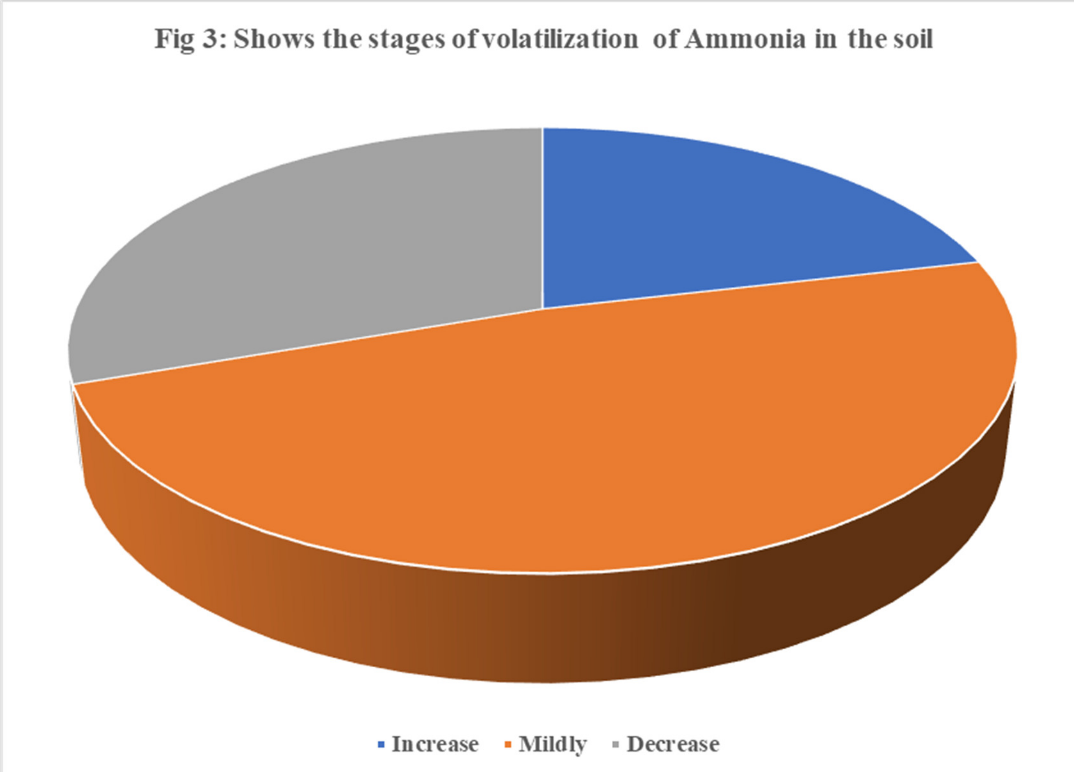


Fig 3: Shows the stages of volatilization of Ammonia in the soil
Increase
Mildly
Decrease

Note: This shows the gradual stages of percentage content after inoculation of biochar, it indicates from the increase to the decrease of ammonia in the soil.

Conclusion

According to this study's meta-analytical methodology, biochar application may affect the soil nitrogen cycle with a broad range of variance based on the features of biochar and soil. In addition, a high advanced pyrolysis process is vital, since biochar formation may result in the development of polluting N2O and NO_x. In conclusion, the long-term impacts of biochar on soil are still an unknown. It is possible that biochars physicochemical qualities and the method of its stabilization may be addressed by its long-term retention in soil, although this has yet to be studied thoroughly.

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