Potential of Biochar as a source of Amendment in degraded Lateritic soils of tropical forest plantations in Kerala, India

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Soils of Kerala in general are lateritic in nature and the fertility of the soil is mainly decided by its organic carbon content. Most of the initial forest plantations of the State were established on organic rich virgin soil immediately after deforestation and hence they were high yielders. But in due course, along with the growth of plantations over rotations soil became sterile due to the loss of their life imparting component ie organic carbon through run off and faster decomposition. In the context of current issues of global warming and soil degradation, it was finally realized that increasing the soil carbon level was the only solution for the sustainable development of plantations and environmental safety. But the question before us is the production of enough organic amendments to meet the current demand in forestry sector. Selective application of organic amendments based on soil carbon stock offer judicious management of available resources. Considering the proven benefits of Biochar, a study is being under taken to produce biochar from various sources such as forest weeds, wastes from municipal and industrial sector etc. and to evaluate the quality of biochar thus produced with respect to nutrient composition. Dalbergia latifolia, a premium-quality timber species internationally known as "Indian Rosewood" is being used as a test crop to study the growth response to biochar. Attempts to raise plantations of rosewood by Forest Department and progressive farmers have shown difficulty in initial establishments and slow growth, especially in degraded, acidic soils of the Western Ghats. Even though the application of organic manures was found to increase the growth rate of rose wood in experimental fields, their availability for establishing large scale plantations is a real problem usually encountered. Considering these factors a study is being under taken to evaluate the potential of biochar as a source of amendment for degraded lateritic soils of forest plantations in Kerala so that the use of other organic manures can be minimized.

Empirical Model for Soybean Productivity (Y) having as Independent Variables NPK (X1) and Biochar Doses (X2)

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Biochar has stable components and electrically charged functional groups. This makes its use in agriculture promising for C sequestration and for soil fertility management. In the studied field experiment in the Brazilian savanna biochar (charcoal) was added to the soil in 5 different doses (0, 2, 4, 8, 16 Mg/ha) and combined with 5 doses of NPK (0, 100, 200, 300, 400 kg/ha) in 4 repetitions in a field experiment (random block design, sandy Haplic Ferralsol). Soybean productivity (Y, kg/ha) was modeled as function of biochar (X2) and NPK (X1). The quality of the model was evaluated by variance analysis. The linear model for the variable was considered significant by the F test, however, the explained variation was only 57.5%. This was increased to 65.6% when quadratic behavior was tested for X1 (NPK) that was expected because of the general response curve to essential nutrients (Roat-Malone, 2006). When quadratic contribution was applied to X2 (Biochar) there was only a little increase in the explained variance (66.5%). This could be neglected since its coefficient was smaller than the respective standard deviation, however, it would make sense to use it since the response (Y) will certainly not be linear to ever increasing X2 (at high doses). This curvature can orient future studies that search for the optimal range of application of this variable. The graphical analysis of the residuals of the linear model suggested a behavior of third order for NPK. Testing it the explained variance by the model increased significantly to 74.7%, the standard error diminished and the statistical significance of the model increased. However this value can be still considered low compared to other experimental models, we considered it satisfactory due to the high variability of the repetitions that makes modeling difficult. The proposed model is the following: Y = 2885.7(37.1) – 84.5(76.3) X1 + 98.8(48.4) X1*X1 – 19.8(8.0) X1*X1*X1 + 22.7(9.1) X2 – 0.4(0.6) X2*X2.The experimental intervals, X1 (0 through 400 kg/ha) and X2 (0 through 16 Mg/ha), were used in this equation to make the response surface analysis. The optimal range for NPK was between 200 and 300 kg/ha. For the biochar there was no optimal region obtained for maximum. Following the response surface in the direction of the maximum inclination repeating the steps of modeling and dislocation when necessary, the optimal region for the investigated phenomenon can be reached.

Effects of the application of biochars with different physicochemical properties on soil functions of two temperate soils

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Biochar can improve soil fertility and biomass production. However, biochar derived from different processes and different raw materials differ with respect to their physicochemical properties, which leads to diverse effects on soil functions after application. Moreover, the prerequisite for an amendment of biochar to soils is the exclusion of negative effects on soil functions and the environment. Therefore this study investigates effects of biochars made by flash pyrolysis from spruce wood (PC), gasification from beech wood (GC) and conventional charcoal produced from beech wood (CC) on functions of two temperate soils in a field trial. The physical and chemical properties differed strongly between the studied biochars. CC and GC exhibited clearly higher pH values (CC: 8,4; GC: 10,6; PC: 4,2), ash and nutrient contents, specific surface areas (CC: 122 m^2g^{-1}; GC: 191 m^2g^{-1}; PC: <0,4 m^2g^{-1}) and micro porosities (CC: 450 m^2g^{-1}; GC: 449 m^2g^{-1}; PC: 262 m^2g^{-1}) than PC. The degree of condensation increased in the order PC (H/C = 0.58) < CC (H/C = 0.45) < GC (H/C = 0.20) and the degree of oxidation decreased in the order PC (O/C = 0.13) > CC (O/C = 0.05) > GC (O/C = 0.04). The different physicochemical properties of the biochars are reflected in the first results of the field trail. While the overall effect of the added biochars (1.5% weight) on soil functions was only small, significant differences between soils mixed with different biochars were nevertheless detected. Applied PC significantly decreased the soil pH and also reduced the actual soil water content, whereas the application of CC and GC significantly increased soil water contents. Concentrations of inorganic and organic pollutants in the biochars did not exceed German environmental standards (precaution values). Our results indicate that negative side-effects of biochar application to soils might outweigh potential merits such as carbon sequestration. Properties of different biochars and their effects on soil functions such as fertility must be considered and regulated prior to the widespread use of biochar as a soil conditioner.

Biochar and plant-root interactions

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Soil amended with biochar may provide benefits to soil fertility and crop production. The improvements may be due to increased soil aeration, moisture retention and nutrient availability, and the mechanisms behind these are likely to vary with soil and plant type, as well as biochar type and rate of application. In general, biochar studies relate higher crop yields with larger root systems, but further quantification of plant roots, other than root biomass, is required: for example in terms of root growth (rate, turnover), root architecture (length, diameter, density), root health (disease resistance), and subsequent impacts on the rhizosphere (the zone of soil that is directly affected by roots) and microbial communities. Our hypothesis is that changes in root dynamics following biochar application will affect moisture and nutrient uptake, soil biogeochemical cycling, and soil carbon dynamics. To test this, the effects of sustainably-sourced charcoal (as a proxy for biochar) on cereal roots and the rhizosphere were studied. Results indicate that root proliferation was more pronounced in char-amended soil and addition of char altered root architecture (total root length, root density). Furthermore, changes in 'bulk soil' vs. 'rhizosphere soil' pH were greater in char-amended soil compared to the control. The implications for biochar will be discussed.

Aplicação de "Biochar" de Eucalipto em Solos Degradados: Atividade do solo e índices físicos

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A elevação das emissões de gases de efeito estufa (GEE) na atmosfera tornou-se um grave problema ambiental e econômico na atualidade, face as suas implicações no aumento da temperatura média do Planeta. Essa elevação é causada, principalmente, pelas emissões de CO_2 (Dióxido de Carbono) via queima de combustíveis fósseis e mudanças no uso e cobertura da terra (desmatamento e queimadas, por exemplo), as quais ocasionam alterações importantes nos estoques naturais de carbono. Isto por que, depois do vapor d'água que causa de 36 a 70% do efeito natural (não incluindo nuvens), o CO_2 é o GEE que mais contribui para o efeito estufa (entre 9 a 26%) (COLE et al., 1995; IPCC, 2007).
Dentre as novas tecnologias desenvolvidas, uma que se encontra em destaque é o "biochar" (biomassa + carvão, em inglês), por se tratar de uma tecnologia potencialmente eficaz no que diz respeito a seqüestro de carbono, além de ser apontado como de grande auxilio na fertilização agricultura, já que aumentaria a quantidade de carbono no solo possibilitando do desenvolvimento microbiano. O "biochar" é produzido por pirólise, que é basicamente a queima de matéria orgânica em ambientes com pouco ou zero de oxigênio No entanto, pensar no uso de "biochar" somente para a questão do aquecimento global esconde sua potencialidade na recuperação de solos e também na remoção via pirólise de produtos químicos indesejáveis como resíduos. Neste contexto, iniciou-se um trabalho de trabalho de pesquisa tendo como objetivo viabilizar a utilização de resíduos orgânicos na forma de "biochar" por meio de pirólise em solos degradados. Os parâmetros em estudo são: os índices físicos e a atividade dos solos incorporados com "biochar" de eucalipto em diferentes texturas e dosagens.

A Simple Method for assessing the potential of Biochar to increase Crop Productivity

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This paper describes a simple procedure to provide an estimation of the potential of biochar to increase productivity of different crops in different soil types, biochar made from different feedstocks and with different microbial additives.
The procedure does not substitute for controlled field trials. However, given the large number of permutations of soils, climate, crops and microbial additives it is impossible to test all potential biochar treatments in the field.
This procedure has the potential to allow the design of strategic and focused field trials.

Biochar como condicionante de substrato para produção de mudas de carvoeiro (*Tachigali paniculata* Aubl.)

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O avanço da fronteira agrícola no Brasil Central tem provocado problemas de degradação ambiental, com perda da biodiversidade e redução dos teores de matéria orgânica dos solos, exigindo ações de recomposição de áreas degradadas (RAD). A produção de mudas destinadas à RAD requer técnicas adequadas para obtenção de plantas sadias e aptas às condições adversas de campo. Uma das formas de produção de mudas vigorosas é o uso de condicionantes de substratos com base em compostos vegetais ricos em carbono. Apesar de estudos apontarem que solos antropomórficos da Amazônia (Terra Preta de Índio) apresentam alta produtividade agrícola sem adubação devido à alta CTC resultante da ação do carvão vegetal das antigas fogueiras dos índios, até o momento, no Brasil Central pouco se sabe sobre os efeitos do carvão vegetal pirogênico (Biochar) na produção de mudas de espécies