feedstock and the pyrolysis temperature had a significant effect on biochar mineralization, with greater carbon loss during the first year for low-temperature than high-temperature biochars, and biochars with lower carbon contents such as maize biochar. During the first year of field experimentation, maize biomass production did not increase with either 1, 3, 12 or 30 tons of biochar applied per hectare. In the first year after application, biochar was not able to decrease nitrogen demands for maize on productive soils.

C13: The effect of application of charcoal residues combined with source of phosphorus and nitrogen in a banana plantation in a yellow Oxisol in the Central Amazon - Brazil

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Agricultural production in the tropics is frequently limited by low soil fertility. Many tropical soils are relatively poor in soil organic matter (SOM), as well as frequently have low cation exchange capacity (CEC), low pH, low calcium (Ca), and phosphorus (P) contents. The existence of an anthropogenic enriched dark soil horizons (Amazonian Dark Earth (ADE) shows that infertile soils may be transformed to permanent fertile and productive soils. The ADE's fertility is most likely linked to an anthropogenic accumulation of P, Ca (from bone apatite) and black carbon that retain those added nutrients. The objective of this study was evaluate the effect of levels of charcoal residues applied combined with a source of mineral phosphorus and nitrogen in the production and nutrition of banana plants in an yellow Oxisol in the Central Amazon. The experiment is being carried at Experimental Research Station of Embrapa in Manaus - Brazil. The experimental design is a confounded factorial with three factors (charcoal, phosphorus and nitrogen) in three levels, each treatment is composed with six plants. The charcoal and fertilizer are applied annually. The parameters measured are nutrient in the banana leaves and soil chemical and physical parameters to monitor the banana nutrition and soil fertility. The harvest and weight of banana bunches are done weekly. The results show significant differences in the soil fertility parameters evaluated.

C14: Biochar application to soil reduces nutrient leaching in the field

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The mechanisms underlying the important yield increases brought about by biochar addition to soil remain poorly understood. We report on a 4-year biochar field study conducted in Colombia, South America, where nutrient leaching was monitored for 2 years under maize and soybean crops. In December 2004, sampling equipment was placed in plots where 0 and 20 t ha-[1] biochar had been applied once in late 2002. Three replicated plots of each treatment were instrumented with suction cup lysimeters and manual tensiometers, and free-draining lysimeters were inserted from a soil pit alongside electronic tensiometers connected to a datalogger. High resolution data on soil matric potential was gathered over the 2005 and 2006 growing seasons. During each season, a maize crop was grown followed by a soybean crop. Constant tension was applied to suction cup lysimeters using battery-powered vacuum pumps connected to vacuum switches, and water collected was sampled weekly. Free-draining water from lysimeters in the soil pit was sampled weekly or when water had been collected. Water samples from both years were analyzed for nutrient content by atomic emission spectrometry, for nitrate by ion chromatography and for ammonium by colorimetric measurement of indophenol. Water moving through soil by saturated flow showed that biochar reduced cumulative leaching below the rooting zone (60cm) by an average of 57, 44 and 18% for Ca, Mg and nitrate-N, respectively over both years. The effect of biochar on ammonium-N was inconsistent among years, where an 89% decrease was observed in 2005 and a large increase in 2006, although absolute amounts were very low. Potassium leaching was reduced by 28% in 2005, and a very slight increase was observed in 2006. For lysimeters placed at 60 cm depth, saturated water fluxes were 32% less with biochar in 2005, and 74% greater in 2006. On a per hectare basis, the flow-weighted average concentration of Ca and Mg in leached water was reduced with biochar application in both years, especially in 2006 when less Ca and Mg were leached despite the fact that water flow with biochar was greater. Therefore, biochar directly retained nutrients against leaching by saturated flow, and not only through its effects on water flow itself.

Reductions in nutrient leaching presumably contributed to the 30 and 140% maize yield increases brought about by biochar additions in 2005 and 2006, respectively. In fact, maize crop uptake of Ca was 26 and 160% greater with biochar in 2005 and 2006, respectively. Similarly, Mg uptake was 32 and 158% greater and total N uptake was 31 and 127% greater. Three and 4yrs after a single biochar addition of 20 t ha-[1], maize yield and nutrient uptake were greater under biochar, while nutrient leaching through saturated flow was decreased.

C15: Soil amendment and slow release fertiliser preparation from castor meal

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This work seeks to determine the best methods of production of partly carbonized waste of biodiesel industry - castor (Ricinus communis) meal - aimed at obtaining material comparable to organic matter of soils Terras Pretas de Índios to be used as a soil amendment and as a matrix material to prepare slow release fertilizers. Analyzes by X-ray fluorescence (XRF), indicates the presence of elements that play important role in the soil biomass nutrients. The comparison between the raw and the carbonized materials shows (Table) that the concentration of the plant nutrient elements, P, Si, K, Ca and Fe increase their concentrations in the bulk carbonized material, as compared with the raw material, while the concentration of sulfur and magnesium, decreases.

Element oxides percentage obtained by XRF for the castor meal samples.

Raw castor meal.

P^2O^5	SO^3	SiO^2	K^2O	CaO	MgO	Al^2O^3	Fe^2O^3	Cl
1.8	1.3	1.3	1.2	0.9	0.8	0.3	0.1	0.1

Carbonized (500ºC, 2 h) castor meal.

P^2O^5	SO^3	SiO^2	K^2O	CaO	MgO	Al^2O^3	Fe^2O^3	Cl
4.1	0.2	2.4	4.8	4.8	0.3	0.3	0.6	0.3

By DRUV-Vis spectroscopy the raw material presents two mainly absorption bands at 220 and 280 nm, typical of electronic transitions into the organic materials ($\pi \rightarrow \pi^*$), and the carbonized material presents continuous absorption from 250 to 850 nm, typical of humic materials with high degree of conjugation. The electron paramagnetic resonance spectroscopy (EPR) study shows that the concentration of free radicals increase from the raw material (number of spin g-1 = 5.38 X 1016) to the carbonized material (1.45 X 1019). Thought this technique, the carbonized material shows performance of a humic-like material in correlation with the results of the DRUV-Vis study. The material was also used to prepare a potassium slow release fertilizer by mixing potassium sulfate with appropriate quantity of the raw material and promoting the carbonization. By tests of leaching with water, aqueous citric and HCl acids, 0.1 mol L 1, the obtained product shows a capacity of K retention of 87.6 %. The retained K will slowly be released to the soil in more satisfactory way with the necessity of the plants. The carbonized material and the potassium slow release fertilizer are been characterized now by the technique of ^{13}C Nuclear Magnetic Resonance (^{13}C-NMR).

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C16: Agronomic effect of humic like substances produced from charcoal

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The agricultural use of products like organic fertilizers, soil ameliorates and physiological stimulator, based on humic substances, has grown rapidly in Brazil in the last two decades. The main sources of humic acids (HA) for commercial use are peat and sedimentary deposits like antracite and leonardite, of which are not renewable resources. Laboratory experiments show that it is possible to produce satisfactory yields of humic-like substances from charcoal using acid treatment. The obtained humic material showed some characteristics that are similar to those extracted from pyrogenic carbon rich soils i.e. polycyclic aromatic nuclei containing peripheric carboxylic groups. These compounds are chemically stable and have a high cation exchange capacity. Although the process used is energy intensive and requires the use of chemicals, the application of this technology on an industrial scale could reduce the costs of production. In this research we evaluated the effect of foliar application of charcoal humic acid solutions on soybean yields. Foliar application rates of 150 L/ha of the HA solution and at a concentration of 300 mg/L (or 45 g of charcoal HA per hectare) was applied to the soybean plots 30 days after seeding. The results show an increase in soybean yield of 17% in relation with the Control, and which correspond to an increase of 600 kg of soybean per hectare. Considering these results, we suggest that the production of humic-like substances for agronomic use from biochar would be economical viable, and should need further investigation.

C17: Biochar decomposition under different water and temperature regimes

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The stability of biochar is an important property that is not only important in the framework of carbon sequestration but also for the sustainability of any soil improvements. Decomposition of plant litter and soil organic matter is known to be strongly influenced by temperature and moisture conditions in soil. Similar information is not available for biochar. Specifically, how the properties of biochar as a function of feedstock and production temperature affect its decomposition and change in oxidation, has not been reported up to now. This study investigates the interactions of feedstock type (corn crop residue and oak wood), production temperature (350°C and 600°C; produced with slow pyrolysis by BEST Energies), presence of microorganisms with either temperature in the environment (4, 10, 20, 30, 45 and 60°C at field capacity) or moisture conditions (anaerobic, aerobic, alternating anaerobic-aerobic at 30°C) on mineralization (mass loss over 1 year incubation; N=4) and change in properties (oxidation by elemental analysis; functional groups by FTIR; cation retention capacity by ion exchange). There was no significant difference between decomposition or oxidation under aerobic and alternating anaerobic-aerobic conditions. Carbon loss was significantly reduced, however, under anaerobic conditions. Some negative surface charge developed on biochars even under continuous anaerobic and submerged conditions. The greatest increase in cation exchange capacity was noted under aerobic conditions for corn biochar produced at 350°C. Over the one year incubation, carbon loss amounted to 12% for corn biochar and 9% for oak biochar. While biochar produced from corn residues at 600°C had a significantly lower carbon loss than when produced at 350°C, there was no significant difference when biochar was produced from oak wood. The sensitivity of oxidation (O/C ratio) to incubation temperature was lower with a lower mass loss. Carbon loss, however, appeared to increase with increasing incubation temperature irrespective of biochar type.

C18: Attenuation of char surface activity over time by natural substances in soil

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An important consideration in the use of biochar as a soil amendment in agriculture is its effect on the mobility and bioavailability of agriculturally important organic chemicals including applied pesticides, residues of incidental contaminants such as legacy pesticides or contaminants in manures or municipal sludges, and natural allelopathic chemicals. Depending on source material and conditions, newly-formed biochar typically has high surface area and microporosity, properties that render it strongly adsorptive. A decrease in the availability of agriculturally important chemicals due to biochar application may have positive or negative effects. Beneficial effects include reduction in pesticide leachability, reduction in bioavailability of incidental contaminants, and reduction in bioavailability of allelochemicals that reduce crop yield or quality. Deleterious effects include reduction in pesticide efficacy (i.e., requiring greater application levels) and reduction in activity of beneficial allelochemicals.