charcoal (0, 8 and 16L per plant) and bone meal (0, 0.2kg and 0.4kg per plant). Physical and chemical properties of the soil were evaluated. The cultivar planted was the BRS-Maués with six plants per plot, at Embrapa Research Station, Manaus, Brazil. The charcoal was triturated in fragments smaller than 10mm. All products were applied surrounding guarana plants in October, 2003. Soil samples were collected at 0 – 10cm depth in April, 2004. The soil of the experiment was classified as a yellow clayey Oxisol. The original value for pH in water was 3.1 and very low levels of available P, Ca, and Mg. The results of soil analyses showed an interaction between charcoal and chicken manure; with enhanced charcoal levels, Mg increased. It is probably because a reduction of leaching of Mg from the chicken manure. The highest level of chicken manure increased soil pH from 4.3 to 5.7, and decrease H+Al content from 7.7 to 4.4 $cmol_c\ dm^{-3}$. Chicken manure also increased P from 68 to 388 mg dm^{-3}, K from 23 to 72 mg dm^{-3}, Ca from 0.8 to 4.3 $cmol_c/dm^3$ and Mg from 0.1 to 1.1 $cmol_c/dm^3$. The results after six months of the application showed no statically difference ($p<0.005$) between treatments with bone meal and charcoal concerning values of P, K, Ca, Mg, H+Al, and pH. The results indicate no difference in the P values with enhancement of P levels from bone meal is probably due the statistical design used that confounded the level of bone meal and chicken manure. Another relevant result is that the sodium levels in soil reached a high concentration enhancing the original level of 8.0 to 67.7$cmol_c/dm^3$. It showed that use of chicken manure may cause salinization. There wasn't difference in clay dispersion between treatments, despite substantial changes in pH and Al, probably because organic matter worked as cementing, maintaining soil flocculated. The experiment is still being evaluated and long term evaluations are needed to indicate the effects of charcoal and its interactions with other products to be used as conditioner for tropical soils.

Use of Charcoal and Wood Carbonization By-Products in Agriculture: Learning With "Terra Preta De Indio"

Benites, Vinicius de M.[1], E.H. Novotny[1], W.G. Teixeira[2], B.E. Madari[3], A.S. Pimenta[4], P.M. Trompowsky[5]

[1]Embrapa Solos, Rio de Janeiro, Brazil [2]Embrapa Amazonia Ocidental; Amazonas, Brazil [3]Embrapa Arroz e Feijao, Goias, Brazil [4]Bricarbras, Parana Brazil [5]IBAMA, Distrito Federal, Brazil

Brazil is the world's highest producer of charcoal, which is responsible for 38.5% of the world production. During the traditional process of carbonization, around 35% of the wood carbon is fixed in the charcoal and the rest is released to the atmosphere in smoke form and by non condensable gases (CO_2, CO, CH_4, etc.). Some technologies are adjusted in Brazil that can recover up to 50% of lost carbon in the form of condensed gases that are explored commercially for industry. The condensed smoke can be distilled producing a wide range of composites, and some by-products such as wood tar, aromatic oils, and pyroligneous liquor. Some of these by-products present chemical characteristics that are similar to the humic substances extracted from Anthropogenic Black Earths and other pyrogenic carbon rich soils suggesting its potential use as raw material for the organic conditioner production. Another important by-product generated in the process is fine charcoal that, in some cases represents up to 15% of the produced charcoal. Reactive organic molecules could be produced from acidified charcoal. These molecules have functional groups that are able to hold nutrients and water in the soil, and are very stable due its polycyclic aromatic structure. The development processes that allow the transformation of charcoal and its by-products into composites with appropriate characteristics for the use as organic conditioner, with high reactivity and stability, is highly desirable and strategic for the agricultural and forest activities in Brazil. Products with these characteristics can enhance the value to the charcoal by creating an innovative uses for a traditional product and to represent a clean development mechanism that has the ability to receive carbon credits considering its long term carbon fixation potential due to the transference of the carbon from the atmosphere to a steadier soil organic matter basin. This work has the objective to congregate experiences and expertise on the agricultural use of coal and its by-products, and to supply information on the availability of these products in Brazil. In such a way one expects to present to the reader the dimension of the impact and the perspectives of use of the traditional knowledge contained in Terra Preta de Indio and the possibility to reproduce these properties in other tropical soils.

Nutrient Retention Characteristics of Chars and the Agronomic Implications

Downie, Adriana[1], L. Van Zwieten[2], W. Doughty[2] and S. Joseph[3]

[1]University of NSW, Department of Materials Science/BEST Energies, 56 Gindurra Road, Somersby, NSW 2250, Australia; [2]NSW Department of Primary Industries, Environmental Centre of Excellence, 1243 Bruxner Highway, Wollongbar, NSW 2477, Australia; [3]BEST Energies

The possible influence of pyrolytic chars on the nutrient retention characteristics of soils has been identified by several groups (Glaser *et al.*, 2001; Lehmann and Rondon, 2006). Glaser *et al* (2001) attributed the high nutrient retention qualities of *Terra Preta de Indio* soils to the extraordinarily high proportions of black carbon. Increases in the availability of major cations, phosphorous and nitrogen have been demonstrated through the addition of wood–based chars to soils (Glaser et al., 2002; Lehmann et al., 2003a). This occurs despite the very low levels of P and N in these chars. Experiments conducted by the NSW DPI and BEST have demonstrated that low nutrient value chars made from greenwaste can increase the nutrient use efficiency by plants of applied N and P This could be explained by; a) char is surface sorbing nutrients maintaining them in the root zone and minimising leaching, b) char is influencing the physical and/or chemical structure of the bulk soil (eg. pH) in a way that positively alters its nutrient cycling and CEC.

We investigated the rates and mechanisms of the interactions between several chars and N and P in a series of batch sorption/desorption tests with nutrient containing effluent. The char, soils and char/soil mixtures were analysed both before and after the addition of nutrients to quantify the nutrient retention characteristics, including the rates of reactions. Phosphorous sorption appears to be correlated with pH and Ca content of char. Both poultry litter and paper sludge chars with high Ca contents have high P sorption capacities (>3000 mg/kg), similar to high sorbing soils, whereas the green waste char has relatively low P sorption capacity (~1000 mg/kg). Examination of the char products after P addition using SEM and EDAX confirmed the precipitation of P in Ca-P complexes. The P sorption kinetic experiments showed that the majority of P sorption occurs within 1 hour, a result consistent with concurrently run column leaching trials, and the precipitation of Ca-P complexes. None of the chars were found to retain significant quantities of N.

When considering that total soil P (0-15cm) ranges from 50 to 3000 mg/kg (Frossard et al., 1995), the results from the experimental program demonstrate that the addition of char can certainly have a positive influence on the P nutrient cycle by increasing the sorption capacity, especially for low P sorbing soils. However, increases in N availability can not be explained via the same mechanism. This work highlights the need for differentiation between the concepts of nutrient retention (or sorption) and nutrient use efficiency by plants when assessing the influence of char on nutrient cycling in soil systems.

Fossard, E., et al. (1995) P. 107-137. in H. Tiessen (ed.) Phosphorous in the global environment. John Wiley and Sons, NY.
Glaser, B. et al. (2002) Bio. Fertil. Soils, 35, 219-230
Lehmann, J., and Rondon, M. (2006) In: Biological Approaches to Sustainable Soil Systems. CRC Press
Lehmann, J. *et al.*, (2003a) Plant Soil, 249, 343-357.