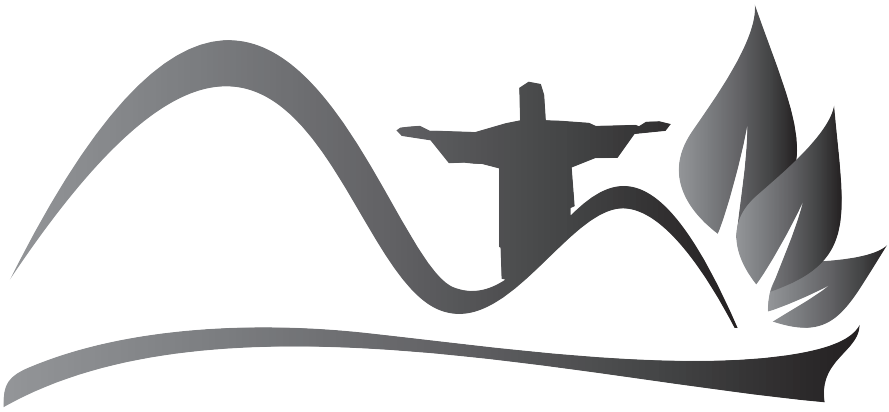
16th WORLD FERTILIZER CONGRESS OF CIEC

TECHNOLOGICAL INNOVATION FOR A SUSTAINABLE TROPICAL AGRICULTURE

PROCEEDINGS

International Scientific Centre of Fertilizers (CIEC)



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CHARCOAL (BIOCHAR) AS SOIL CONDITIONER TO ENHANCE FERTILIZERS AND WATER USE EFFICIENCY IN AGRICULTURE IN ACID TROPICAL SOILS IN THE CENTRAL AMAZON BASIN

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Introduction

Biochar is a name for charred organic material (charcoal - carvão vegetal in Portuguese) when it is used as a soil amendment. Different methods of pyrolysis is used to make charcoal. In the Amazon the traditional way is the called "*caiera*", that consist in earth kiln is digged and fulfilled with vegetal debris (mainly trunks of trees) its is covered with soill. Some opening vents in the soil allow to control the flux of oxygen into the kiln. Another traditional technique is the called hot tail (*rabo quente*) which is still a simple technique using a kiln made with bricks. After the kiln is filled a small fire is ignted at the kiln entrance then the door is sealed with soil and the vegetal residues is left to undergo incomplete combustion, creating charcoal and some ammount of ash (Swami et al. 2009). Charcoal as soil amendment is traditionally used by the population in the Amazon to enhance soils to cultivate some horticultural crops as medicines and spices. Moreover in the Amazon ash from burned vegetation is the lime and the fertilizers used in the traditional slash and burn or shifting cultivation, a system of land clearing practiced by several thousand of small farmers in the Amazon. In spite of potential agronomic benefits to enhance soil quality (Teixeira et al., 2010) biochar has also the potential to reduce carbon emissions (Lehmann et al., 2005). Many publications sad that biochar can increase soil fertility, increase agricultural productivity, and provide protection against some foliar and soilborne diseases. Furthermore, adding biochar can prolongate the time of cultivation it may reduces pressure on forests areas to agriculture as happens in Amazonian Dark Eath sites (German, 2003).

The Amazon soils comprise a large spectrum of soil with different potential to be used in the agriculture, in the Central Amazon the soils of the upland areas are mainly dystrofic Ferralsols and Acrisols (Teixeira et al., 2011). However in the floodplains of many rivers, rich in sediments, the predominant soils are eutrofic Gleysols and Fluvisols. In the upland area in the Central Amazon, the only fertile soil (eutrofic) were the pretic Anthrosols (Amazonian Dark Earths), called regionally as Terra Preta de Ìndio, this type of soil has many good agronomic qualities (Teixeira et al., 2010) and can be considered the source of inspiration to apply biochar in soils (Benitez et al., 2010; Steiner et al., 2010; Steiner et al., 2009). The TPI shows normally a high concentration of P, Ca, Mn and large stocks of carbon. Moreover a large amount of the carbon in this type of soil seems to be of pyrogenic origin (Glaser et al.2001) and has large amount of charge (CEC) (Liang et al., 2010). This article summarize result of many experiments conducted in 15 years of research with biochar in nursery and field experiments in the Central Amazon.

Material and methods

The material and methods used in the experiments were detailed described in the publications listed in the reference section.

Results and discussion

The results summarize the main results of many experiments conducted by the authors et al during the last decade

Fields experiments

In Central Amazon many fields experiments were conducted testing different levels of biochar in combination with different treatments (organic and mineral fertilizers). Also the response in productivity in annual crops (rice and sorghum) were studied (Steiner et al., 2007). In experiments with perennial crops, Banana (Musa sp) and Guarana (Paulinia

cupana) the treatments with addition of biochar reconfirm the previous results of potential enhance in the productivity for a longer period and to improve the CEC, respectively the studies of Steiner et al., 2007, Steiner et al., 2008 and Arruda and Teixiera, 2010 and Arruda et al. 2012. In an field experiment, with application of charcoal pieces in planting holes for a banana plantation (Steiner et al., 2009) addition of charcoal inreased the water hold at potential of 100 kPa that indicate a that charcoal ammendment enhace soil pores with radius of ~ 0.015 mm. Either biochar promoted the aggregation with soil pores with pores of this size or biochar´s porosity itself was responsible for this increase. The experiments with application of biochars in the Central Amazon show that only mineral fertilizer can also not guarantee higher productivity for a long period. Is that necessary to apply some source of organic matter in combination with the fertilizers and biochar is an option. In spite of the difficult to isolate single mechanism to explain some improvement in productivity and soil quality in acid tropical soils, the results are clearly related with reduction of leaching rates and enhancing efficiency of fertilization management.

Nursery experiments

Experiments were conducted using charcoal as component o growing media in nurseries for different plant species: Guaraná (Paulinia cupana); Crajiru (Arabidae chica) and Brazil Nut (Bertholletia excelsa) the results are published respectively in Arruda et al., (2007); Souza et al., (2007) and Nunes and Teixeira, (2010). The main conclusion of these experiments is that charcoal pieces can be a component of growing media in substitution to A horizon and commercial components (as vermiculite, montmorilonite) with similar results and the advantage to be cheaper and regionally available. The water holding capacity in lower tension of soil with adition of charcoal can be similar or higher that provide by addition of active clays.

In the future more sophisticated technologies may produce biochar by specific demand combining more stable charred material to reduce emission or to delivery nutrients and to enhance cation exchange capacity (CEC). Many benefits of charcoal application related in the literature are probably related with the liming effect of ash that “contaminated” many biochar. Application of biochar with large amount of ash in alkaline soils some advantages may change to disadvantages. The most biochar can not be commercialized in the Brazil as fertilizer as do not attend the minimum required by legislation by the most part of nutrients and it should be refered as soil ammendment or conditioner.

Conclusions

Biochar has a potential when combined with fertilizers (mineral and organic) to enhance productivity in the dystrofic Ferrralsols in the Central Amazon.

Biochar has a potential to replace the A horizon in the nursery as a component of the growing media

Biochar from wood residues done in the traditional ways in the central Amazon (caieras and rabo quente) is a mixed of charred material and ash on liming, fertilizing and enhace water hold capacity.

Keywords: Biochar, tropical soils, CEC, Latossolo Amarelo

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Figure 1. Traditional use of charcoal pieces (biochar) to enhance soil to cultivated horticultural crops in the Amazon