3rd International Biochar Conference
IBI 2010
Progressing from Terra Preta de Índios to the Whole World

Does biochar lower the energy required for plants to take up nutrients by changing the redox potential and the concentration gradients of nutrients in the rhizosphere

Joseph, SD[a,d*]; Camps-Arbestain, M[b]; Donne, S[c]; Munroe, P[a]; Chia, CH[a]; Lin, Y[a]; Ziolkowski, A[d]

[a]School of Material Science and Engineering, University of NSW, NSW 2052, Australia; [b]New Zealand Biochar Research Center, Private Bag 11222, Massey University, 4442 Palmerston North, New Zealand; [c]Discipline of Chemistry, University of Newcastle, Callaghan, NSW 2308, Australia; [d]Anthroterra Pty, Ltd, 31 Pile Rd Somersby, NSW 2250, Australia
[*]E-mail: joey.stephen@gmail.com

Key words: *Biochar, Redox potential, rhizosphere*

Abstract

The energy required for plants to take in nutrients is given by the equation:

(1) $\Delta\mu = RT\ln Ci/Co + z\Delta E$

The first term is the concentration gradient (Ci is the concentration inside the cell and Co is outside the cell) and the second term is the electrical potential difference. [2]

Biochar and biochar mineral complexes produced at low temperatures are semi-conductors. [1] They can have a high radical content [3] and have Eh and pH values that may differ to that of the soil to which it is applied. The pH of the biochar will depend on the balance of the alkalinity of the ashes relative to the acidity of the organic fraction, whereas Eh will depend on the electron density of the final product. An Eh gradient is expected to exist across a biochar transversal section, as a result of the different exposure to O_2.s. When placed in soils, the bulk and the local pH and Eh will change accordingly in response to the new conditions.

Root hairs penetrate the pores and attach to the surfaces of biochars and biochar mineral complexes. [4] These roots can exude acids that may promote the dissolution of the ash-fraction of the biochar; increasing nutrient availability. Abiotic and biotic oxidation of biochar has been reported [2], thus reflecting the electron transfers occurring at the biochar-soil interfaces.

To determine the extent to which these processes occur, a series of detailed measurements have been carried out to determine the redox potential (i) of different biochars, (ii) across a section within a high mineral-ash biochar and (iii) of soil and biochar with and without plants. The results to date indicate that high mineral-ash chars and biochar-mineral complexes do alter the local Eh and pH and reduce the energy required for nutrient uptake in the roots.

---

[1] Bourke, J., Manley-Harris, M., Fushimi, C.,Dowaki, K., Nunoura,T. and Antal,M. J. (2007) 'Do all carbonized charcoals have the same chemical structure? 2. A model of the chemical structure of carbonized charcoal', Industrial Engineering and Chemical Research,vol 46, pp5954–5967.

[2] Chesworth (2008) Encyclopedia of soil science, (Springer: Netherlands) Cheng C-H, Lehmann J, Thies JE, Burton SD, Engelhard MH (2006) Oxidation of black carbon by biotic and abiotic processes. Organic Geochemistry 37(11), 1477-1488.

[3] Emmerich, FG, Rettori C, Luengo CA. 1991. ESR in heat treated carbons from the endocarp of babassu coconut. Carbon 29, 305-311.

[4] Lehmann J, Joseph S. 2009 Biochar for environmental management. Science and technology.(Earthscan: London) 416 pp.