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Biochar from cashew residue enhances silicon adsorption and reduces cohesion and mechanical resistance at meso- and micro-structural scales of soil with cohesive character

Ícaro Vasconcelos do Nascimento [a, 1, *], Emanuela Barbosa dos Santos [a], Angélica da Silva Lopes [a], Alexandre dos Santos Queiroz [a], Crisanto Dias Teixeira Filho [a], Ricardo Espíndola Romero [a], Mirian Cristina Gomes Costa [a], Odair Pastor Ferreira [b], Antônio Gomes Souza Filho [c], Laís Gomes Fregolente [c], Francisca Gleiciane da Silva [a], Arthur Prudêncio de Araujo Pereira [a], Helon Hébano de Freitas Sousa [a], Viviane Sobucki [d], José Miguel Reichert [e], Jaedson Cláudio Anunciato Mota [a]

[a] Federal University of Ceará (UFC), Soil Science Department, 2977, Av. Mister Hull, Campus do Pici, Fortaleza, CE 60356-001, Brazil
[b] State University of Londrina (UEL), Department of Chemistry, Highway Celso Garcia Cid (445) - km 380, Londrina, PR 86050-482, Brazil
[c] Federal University of Ceará (UFC), Department of Physics, Campus do Pici, Fortaleza, CE 60455-900, Brazil
[d] Federal University of Santa Maria (UFSM), Soils Department, Av. Roraima 1000, Rural Sciences Center, 42, Santa Maria, RS 97105-900, Brazil
[e] Federal University of Pernambuco (UFPE), Nuclear Engineering Department, Av. Prof. Luis Freire, 1000, Recife, PE 50.740-545, Brazil

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ABSTRACT

Horizons with cohesive character impose physical restraints on plant development, particularly when it occurs near the soil surface. Howbeit, the genesis of cohesive character in soils is associated with temporary and reversible cementation by amorphous silica. Thus, we hypothesized that the biochar obtained from residues from cashew processing would improve soil porosity and promotes silicon adsorption, consequently reducing cohesion and mechanical resistance while improving the physical quality of soils with cohesive character. We collected soil samples with deformed structure from the Bt1 horizon of a Typic Haplustult with cohesive character in northeast Brazil. These samples were used to prepare test substrates by combining air-dried and sieved soil samples and biochar at application rates of 0, 5, 10, 20, and 40 Mg ha^{-1}. All the samples in each treatment underwent ten cycles of wetting and drying (one cycle per week) to allow the manifestation of the cohesive character. Subsequently, we assessed silicon adsorption capacity, soil bulk density, porosity, soil penetration resistance, tensile strength, and rheometric properties. In the 5 and 10 Mg ha^{-1} doses, the physical quality remained like the control treatment (0 Mg ha^{-1}). The 20 and 40 Mg ha^{-1} doses resulted in increased soil silicon adsorption capacity (+7.6 and +15.3%, respectively), total porosity (+2.0 and +1.9%, respectively), and macroporosity (+14.6 and +15.3%, respectively), compared to the treatment without biochar. Conversely, these doses led to a reduction in soil bulk density (-0.1 and −0.8%, respectively), penetration resistance (-16.2 and −16.1%, respectively), tensile strength (-24.2 and −36.5%, respectively), deformation at the end of the linear viscoelastic range (-6.3 and −10.5%, respectively), shear stress at the end of the linear viscoelastic range (-16.4 and −26.9%, respectively), and maximum shear stress (-13.7 and −22.3%, respectively). In conclusion, the application of biochar improved soil porosity and promoted silicon adsorption, thus reducing the bulk density, cohesion, and mechanical resistance, enhancing the physical quality of soils with cohesive character, especially for doses of 20 and 40 Mg ha^{-1}.