Phosphate biochar fertilizers improve phosphorus accessibility in agricultural soils[1]

Stella Cristiani Gonçalves Matoso[2], Paulo Guilherme Salvador Wadt[3], Valdomiro Severino de Souza Júnior[4], Xosé Lois Otero Pérez[5]

[1] Work undertaken with support from the National Council for Scientific and Technological Development - CNPq. [2] Teacher, Institute of Education, Science and Technology of Rondônia, Colorado do Oeste, RO. [3] Researcher, Embrapa Rondônia, Porto Velho, RO. [4] Teacher, Federal Rural University of Pernambuco, Recife, PE. [5] Teacher, University of Santiago de Compostela, Campus Sur, Santiago de Compostela, Spain.

Resumo — The use of biochar as a soil amendment offers significant agronomic and environmental benefits. These benefits include improved soil structure and water retention, enhanced fertility, increased crop yields, effective carbon sequestration, and reduced greenhouse gas emissions. Biochar is particularly effective at enhancing soil fertility by reducing phosphate fixation, thereby increasing the bioavailability of phosphorus (P). A compelling aspect of biochar worth further exploration is its potential to act directly as a phosphorus source, in addition to its traditional role in soil improvement. In our study, we developed mineral-biochar composites by integrating various biomass sources (specifically rice and coffee husks), soil textures (sandy and clayey), and phosphate fertilizers (namely triple superphosphate) to produce biochars with high phosphorus content. We conducted a series of phosphorus sorption and desorption experiments across different soil mineralogies, comparing these novel biochars to a standard reference source (KH_2PO_4). The biochars exhibited a range of phosphorus availability, from labile to non-labile forms. Our results showed that incorporating these phosphorus-enriched biochars, especially those mixed with sandy rather than clayey soils, significantly enhanced phosphorus availability in all soils tested. The type of biomass used in the biochar production process also significantly affected phosphorus availability, with biochars derived from coffee husks demonstrating greater effectiveness than those from rice husks. Using these enriched biochars as a phosphorus source before pyrolysis was associated with high phosphorus retention and limited desorption potential compared to the reference source (KH_2PO_4). Crucially, our analysis indicated no destabilization of the soil's mineral matrix, even at the highest phosphorus and biochar levels. Biochars made from coffee husks were more effective than those from rice husks in preventing phosphorus fixation in the soil. Incorporating sandy soil into the biochar formulation, as opposed to clayey soil, significantly improved phosphorus availability across various soil mineralogies. Enhancing biochar with phosphate fertilizers was a key factor in phosphorus availability in soil, making post-pyrolysis enriched biochars an effective strategy for boosting phosphorus bioavailability in soils with varying degrees of weathering.

Termos para indexação: phosphorus, pyrolysis, sorption, fixation, non-labile.