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Nitrogen availability from residues-based biochar at two pyrolisis temperatures

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Biochar has been studied for several applications, such as soil quality improvement, heavy metals remediation and N2O mitigation. Considering the soil quality improvement aspect it is desirable to evaluate if the nitrogen content in biochar samples obtained from several residues used as the biomass sources could be available for plants. Samples of sewage sludge (SS), coffee grounds (CG), chicken manure (CM) and fungi mycelia (FM) were pyrolyzed at two temperatures, 400 and 700 oC (indicated by the number 4 and 7 in this abstract, respectively), in order to obtain the biochar samples. The Kjeldahl nitrogen of biochar was (% m/m): 3.0 (CM4, CG7, FM7 and CG4); 2.0 (CM7 e SS4); 3.4 (FM7); 1.4 (SS7), with organic carbon (potassium dichromate method) ranging from 2.0 to 3.0% for all but CG4 (6%). The C/N ratio of biochar samples was: 9 (CM4, SS4 and CG7); 11 (CM7); 15 (SS7); 7 (FM4 and FM7); 21 (CG4). The eight soil + biochar resulting mixtures, prepared using the equivalent to 60 t/ha of biochar (about 3% w/w), and one additional control treatment (no biochar added) were incubated for 90 days, with four replications of each treatment per time evaluated. Inorganic nitrogen and soil pH measurements were performed for all treatments at 0, 5, 15, 30, 60 and 90 days of incubation. Soil moisture was kept at 40% soil water holding capacity, by weighting, during the experiment. The data was submitted to ANOVA with Tukey's average comparison test ($p < 0.05$). No significative pH changes were observed during the incubation of biochar samples. At the initial incubation time (zero days) no statistical difference was observed among biochar sources or pyrolisis temperatures. After five days of incubation SS4 and CM4 showed significant inorganic nitrogen release compared to all other treatments, behavior repeated at all the following times evaluated. For CM7, FM4 and FM7 maximum nitrogen availability was observed after 15 days, while it occurred after 90 days for SS4. After 90 days, only SS4 and CM4 presented a positive nitrogen balance, reaching 8 and 9 % of the nitrogen added by biochar samples release to the soil, respectively. A first order kinetic model was adjusted for SS4 nitrogen release, enabling the calculation of half life (10 days), potential available nitrogen (76.5 mg/kg) and the speed of the process. However, compared to SS4 the standard nitrogen availability of sewage sludge is up to 30% of its Kjeldahl nitrogen. For organic residues with C/N ratios lower than 20 applied to the soil a fast degradation, with the corresponding increase in inorganic nitrogen availability is expect. Although all the biochar samples tested had C/N ratios below that cutting point, just 2 of 8 presented inorganic nitrogen available in the soil+biochar mixtures. These results show that soil incubation tests are ultimate for the evaluation of the nitrogen potential release to the soil. Low temperature SS based biochar may offer additional nitrogen release to soil besides other soil conditioning properties.