

PRODUCTION OF UREA INTERCALATED BIOCHAR FROM AGRICULTURAL WASTE AND EVALUATION OF ITS POTENTIAL BENEFITS

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ABSTRACT

Urea-intercalated biochar (UIBC) enhances nitrogen retention, however, its low nitrogen content leads to high application rates. This study optimized urea adsorption in biochar using different feedstocks (coir dust and groundnut shell), concentrations (50 % and 100 %), and soaking methods (capillary action and direct soaking). Statistical analysis (two-way ANOVA, $P < 0.0001$) confirmed that coir dust with capillary action and 100% urea exhibited the highest nitrogen content (38.31 ± 0.76 %). This formulation was further optimized by testing three particle sizes (0.25 mm, 0.5 mm, 1mm) and three urea concentrations (50 %, 75 %, 100 %), where coir dust, capillary action, 0.25mm, 100% UIBC recorded the highest nitrogen content 40.13 ± 0.51 %. Nitrogen leaching and release patterns of UIBC were assessed with seven treatments; T1 (control), T2–T4 (100 %, 75 %, 50 % urea), and T5–T7 (100 %, 75 %, 50 % UIBC), in a completely randomized design ($P < 0.0001$) with four replicates. In the incubation study, T5 (100% UIBC) demonstrated significantly higher available nitrogen (66.5 ± 3.5 gkg⁻¹), cation exchange capacity (37.575 ± 0.70 cmol⁺kg⁻¹), microbial respiration (9.685 ± 0.98 mg 100g⁻¹) and total organic carbon T5 (45.97 ± 1.51 %) compared to T2 (100% urea) (54.25 ± 3.03 gkg⁻¹, 34.625 ± 1.07 cmol⁺kg⁻¹, 7.047 ± 1.4 mg 100g⁻¹ and 22.56 ± 2.22 %, respectively). In the leaching study, cumulative nitrate loss was lower in T5 (4.19 ± 0.04 mg) compared to T2 (5.38 ± 0.05 mg), indicating reduced nitrogen leaching in UIBC treatments. Overall, this study demonstrated the potential of urea-intercalated biochar treatments to enhance nitrogen retention, soil quality and reduce leaching losses.

Keywords: urea-intercalated-biochar, slow-release nitrogen