Charcoal and Sago Bark Ash Regulates Ammonium Adsorption and Desorption in an Acid Soil

ABSTRACT

Excessive N fertilizer use in agriculture results in the release of inorganic N contaminants into surface and groundwater bodies, and other negative environmental effects. The combined application of N fertilizers with charcoal and sago bark ash could help reduce these negative impacts. The objective of this sorption study was to examine the effects of the co-application of charcoal and sago bark ash with ammonium chloride in regulating the adsorption and release of $NH4^+$ in an acid soil. This soil used in the laboratory study was Bekenu series (Typic Paleudults). The treatments evaluated were: (i) 300 g soil only, (ii) 300 g charcoal only, (iii) 300 g sago bark ash only, (iv) 300 g soil + 15.42 g charcoal, (v) 300 g soil + 7.71 g sago bark ash, and (vi) 300 g soil + 15.42 g charcoal + 7.71 g sago bark ash. Regardless of the concentration of the isonormal solution, sago bark ash (T3) showed the highest NH_4^+ adsorption at equilibrium (Q_e) and NH_4^+ desorbed (Qde). The results for T3 for Q_e and Qd_e were 3.88 mg L−1 and 3.80 mg g−1, respectively, for the 400 mg N L−1 isonormal solution followed by T2 with values of 3.46 mg L −1 and 3.30 mg g−1, respectively. For treatments T2 and T3 that resulted in higher Q_e and Qd_e for NH_4^+, soil was not included. However, in practical terms, any of the treatments T4, T5 and T6 that included mixing the amendments with soil are better since the results of these treatments were not significantly different in terms of Q_e and Qd_e for NH_4^+. This is despite the fact that T4, T5 and T6 resulted in lower Q_e and Qd_e for NH_4^+ compared to T2 and T3. The results also showed a positive linear relationship between NH_4^+ adsorption and the addition of N. This indicates that NH_4^+ can be retained temporarily by the amendments. The insignificant R2 (ranging from 0.10 to 0.38) of the Langmuir regression equations suggest that the NH_4^+ adsorption data did not fit the Langmuir isotherms well. Future studies could explore fitting the NH_4^+ sorption data into other sorption models. The higher adsorption of NH_4^+ by the treatment with charcoal is related to its high number of adsorption sites or negative charges of these materials. Incorporating charcoal and sago bark ash as soil amendments in agriculture has the potential to reduce the usage of chemical fertilizers. The reliance on commercial lime could also be reduced due to the alkaline characteristics of these materials. Therefore, the co-application of charcoal and sago bark ash could contribute to improve the utilization of N fertilizer by effectively controlling NH_4^+ availability for timely crop use, reducing losses, and preventing soil and water pollution