Keywords Bio char; Compost-modi ed bio char; Lead smelting slag; Pb stabilization

Introduction

High concentrations of lead in soil that is contaminated by lead slag is dangerous to man and the ecosystem. e level of Pb above background concentrations in soil a ects soil fertility, plant and animal

was measured using $CaCl_2$ batch leaching experiment, yield and Pb uptake by maize plant.

Experimental Soil Collection

e soil sample for this study was randomly collected from an abandoned lead smelting slag contaminated site in Ibadan, Nigeria. e site lies between longitude 27°24'N and latitude 4°00'E at an elevation of 174 m above sea level. e large expanse of agricultural land in this area has been made unproductive due to the impact of the LSS illegally dumped on the land several years ago. Soils were sampled at di erent points at 15 cm depth and mixed to form composite sample which was transported to the laboratory.

Amendments Preparation

e bio chars were produced from rice husk and cashew nut shell. ese agricultural residues were chosen due to their abundance in Nigeria and in other places in the world. eir use as bio char sources will minimize the problem of managing their waste. Compost was prepared from wild sun ower (*Tithonia diversifolia*) and poultry liter in ratio 3:1 of sun ower to poultry manure for 12 weeks [9]. e di erent agricultural residues (rice husk and cashew nut shell) collected were pyrolysed locally in the presence of low oxygen using a simple, low cost two barrel charcoal retort method [16] at approximate pyrolysis temperature between 450 and 500°C. e produced chars were ground

e experimental soils were also analysed for the total environmentally available Pb [5].

Results and Discussion

Physico-chemical characteristics of soil and the amendments

Table 1 presents the Physico-chemical properties of the soil, bio chars and compost. e pH of unamended soil was 5.7 which show that the soil was acidic. e pH of CNSB is slightly acidic (6.30) compared to the pH of rice RHB and compost which are alkaline. e acidic pH of CNSB can be attributed to its anacardic acids content [23]. e organic carbon of the soil was as low as 1.80%, which could be attributed to the high content of the slag which prevented vegetation of the soil. e concentration of Pb in the untreated soil was 18,300 mg/kg. Compost, RHB and CNSB have low Pb contents of 1.50, 0.90 and 1.2 mg/kg respectively, suggesting that there is no considerable contribution of Pb level when these materials are applied to the soil. e bio chars RHB thrived with the three rates. e plants grown on them displayed healthy outlook and taller height with higher number of leaves and leaf areas. Plant parameters performed better with mixture of compost and the bio chars at lower rates of 50 g/500 g soil than when the two

bio chars were used singly at very high rates of 200 g/500 g soil. e reason for this observation may be due to the combined e ect of CEC and alkalinity impacted on the soil by the compost-modi ed RHB. As can be observed in Table 1, compost had the highest CEC followed by RHB and then CNSB. Cation exchange capacity of the amendments re ected their potential nutrient holding capacity. e combining e ects of nutrient holding capacities of compost and RHB on making the contaminated soil fertile yielded healthier plants.

E ects of treatments on maize plant dry biomass

e response of maize plant in terms of root and shoot dry biomass is presented in Figure 3. In view of the amendment type and rate, compost alone promoted the highest root and shoot biomass. For all other treatments, with the exception of CNSB at the rate of 200 g/500 g the root and shoot biomass yields were higher than those of the control plant. Cashew nut shell bio char at the highest rate (200 g/500 g) produced the least root (0.1) and shoot (0.25) biomass values. However, addition of compost to the CNSB even at a lower rate (50 (1:1) g/500 g) improved the performance of the bio char with 0.65 root and 1.45 shoot biomass values. e observed less performance of the CNSB may be associated with its acidic nature, the condition which is not favourable for plant growth. Unlike CNSB, the pH values of both compost (8.70) and RHB (7.40) are alkaline. e observed desirable performance of compost-modi ed CNSB may also be connected to this alkaline nature of compost which increased the pH of CNSB and therefore favours plant growth. is suggests that pH of the bio char is an important factor to consider when developing bio char remediation of heavy metals contaminated soils.

E ects of amendment on post-harvest soil Pb concentration

e concentrations of Pb measured in soil, maize plant root and shoot a er harvesting are shown in Table 2. Total soil Pb content was reduced from 15,340 mg/kg in the control soil a er harvesting to concentrations which ranged from 8,250 (C2) to 12750 mg/kg (CNSB1) in the treated soils. Similarly, total root Pb content was reduced from

Inorganic chemical composition of the amendments perhaps also played an important role in the stabilization of Pb in the soil and uptake by plant. As presented in Table 1, compost had high phosphorus content. Phosphorus reacts with Pb in soil to form pyromorphite [Pb $(PO_4)_3OH$], the most stable compound of Pb in the environment [30]. Xu et al. [28] identified peaks that were associated with CO_3^{2-} and PO_4^{3-} in FTIR spectra of Rice husk-derived biochar. This suggests that stabilization of Pb through precipitation of lead as carbonate and phosphate is a possibility. Typical XRF chemical characterization of RH ash revealed that it contains up to 92% SiO_2

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