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Mineral Characterization of Termite Mounds in Abuja campus of University of Port Harcourt, Nigeria

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Abstract:

Farmers in crop production are faced yearly with challenges of climate change, soil degradation, nutrient lose, land over use etc. These challenges led to survey of termite mounds to access its mineralization in Abuja campus, University of Port Harcourt. The aim was to observe and take samples, quantify its physiochemical content and as substitute to amend degraded soil and support crop production. Four termite mounds were broken up, sampled, labeled A-D and ordinary soil (GS) from site. Immediate Soils colours were determined with Munsell-Color Charts 2009 Revision: A-5YR ¾ dark reddish brown, B-7.5YR 4/6 strong brown, C-10YR ¾ dark yellowish brown and D-10YR 4/6-dark yellowish brown. Air dried sampled soils prepared, sent to laboratory for analysis. Mean values of lowest and highest parameters are: pH: A 4.01, C 6.30; EC: B 53, C 217µS/cm; %N: B 0.05, C 0.08; %OC: A 0.48, C 0.94; P: D 4.17, C 19.53 mg/Kg; Ca: B 0.96,C 5.09 mg/Kg; Mg: D 0.20,C 5.0.63 cmol/Kg; K: D 0.09, 0.108 cmol /Kg; Na: B,D 0.28,C 0.29 cmol/Kg; Acidity: C 2.65,D 12.8 cmol/Kg; Al: C 0.65,B 2.30 cmol/Kg; ECEC: C 8.79,D 16.23 cmol/Kg; Mn: B 4.33,C 45.32 mg/Kg; Fe: B 23.96,C 51.20 mg/Kg; Cu: D 0.78,C 1.19 mg/Kg; Zn: B 5.35,A 20.21 mg/Kg; %Clay: C 17.7,B,D 33.7; %Silt: D 5.64, A 11.64; %Sand: A 55.66, C 72.66. Results revealed increases in elements, minerals salts, acidity, ECEC, clay and silt than ordinary soil (GS). Increases attributed to decayed vegetative materials and earth crust movement by termites. Termite mounds is suitable for soil amendment, reduction in fertilizer application, support degradation and promote environmental wellbeing.

Keywords: Elements and Mineral salts; Physiochemical; Soil color; Termite mound

Introduction: The bulk of agricultural crop production in Nigeria are predominantly from the subsistence farmers scattered all over the Nigerian state. They cultivate farmland to plant and produce food items for consumption (Awoyemi, Afolabi and Akomolafe, 2017); (Tochukwu, Omoyele, Olanipekun and Adeyemi, 2021). Though, this set of farmers are faced with many notable constraints in the course of crop production which else have impacted on producing enough food for human and animal consumption. For instance, a decrease in farmland size, poor soil health, pest infestation, lack of inorganic fertilizer and credit facilities **(**Begna,2020)**,** (Gavrilova, 2021), (Udemezue, 2019); unavailability of healthy viable and sizable seed for planting (Okonwu, Ifenuaguta, Ogazie and Agogbua, 2022); climate change, unstable pricing of agricultural produces, labour issues (Begna, 2020).Interestingly, soil which is the bed rock of agricultural activities, has over the years declined in its nutrients supply substantially in most arable farmlands and as such does not provide the needed nutrients to support crop production due to over use (Zajícová and Chuman ,2019). Thus, there is need to source for other alternative ways to upkeep soil health and still produce enough food for consumption. Sources of enriching soil to maintain optimal performance include clearing of new forested land (Mullan, Sills, Pattanayak, Cavilia-Harris, 2017), application of organic manure, inorganic fertilizer, mixed cropping, farmyard manure and termite mound soils (Apori, Murongo, Hanyabui, Atiah and Byalebeka 2020).

There are increasing awareness towards the use of termite mounds as soil amendment agent where organic and inorganic manures are becoming difficult to access (Zhou, Li, M. and Achal, 2025; Deguine, Aubertot, Flor, Lescourret, Wyckhuys and Ratnadass, 2021). Several investigations have been carried out as to the suitability of termite mound soil amendment to support the growth of plant. According to Chisanga, Mbega and Ndakidemi (2020), termite mounds showed moderately high amount of N.P.K and micronutrients when applied, hence would help farmers in crop production. López-Hernández (2023) revealed that termite mounds presence in farms boosts soil penetrability and infiltration, controls nutrient dynamics and therefore a practice in rural communities in crop production practice, while in the case of Subi and Sheela (2020), revealed that lots of investigations on termite mound soil, possessed great microbial population and organic matter degrading enzymes; nevertheless few other studies considered nutrient holding capacity and crop yield when termite mound soil are used as soil amendment (Subi and Sheela, 2020; Enagbonma and Babalola, 2019; Tilahun, Cornelis, Sleutel, Nigussie, Dume and Van Ranst, 2021). Consequently, this research objective focuses on Termite mounds evaluation of its physicochemical contents and how it could be used as a source of soil amendment by farmers to boost soil nutrient in crop production over reduction in fertilizer application, thus protecting the environment and biodiversity within Abuja campus of University of Port Harcourt.

Termite is in the family of Isoptera, with over 2000 species, mostly found in tropical and subtropical climates (Khan and Ahmad, 2018; Buczkowski and Bertelsmeier, 2017). Termite eat wood and plant rich in cellulose, while some have symbiotic bacteria or protozoans that help them digest wood (Ali, Hemeda and Abdelaliem, 2019). Termite lives in large communal groups or colonies with at least one king and queen for reproduction with lots of workers and soldiers in the mound consisting of termite fecal matter, saliva and mud (van Huis, 2017) which accommodates them, preserve and protect them from harsh environmental forces. Many species found in Africa and sub West Africa live in mounds of various sizes, colours, heights and width (Davies, Brodrick, Parr and Asner, 2020; van Huis, 2017). Termite is edible, contain fat, oil, minerals and vitamins (Kolobe, 2023; Fombong and Kinyuru, 2018) and fungus garden that grows on mound provide edible mushrooms and used as medicine by the native people (Davies, *et al*., 2020). Mounds often used as household improvement agents for example, making of bricks, pots, plastering of houses. Regularly used as fertilizer (Davies *et al.*, 2020). Yet with several termite benefits, they are troublesome and very destructive to building (Ugbomeh and Diboyesuku, 2019), feed on wood arbitrarily, and have a habit to destroy timber and other wooden materials of significance to man in the farm and cause damage to crop and a significant yield lose(Yêyinou Loko, Orobiyi, Agre, Dansi, Tamò, and Roisin, 2017).Farmers in most localities of Nigeria consider termite mounds to be rich with mineral salts that could be available to crop when crushed into pieces or cropped near termite mound (Momah, Andre-Obayanju, Odokuma-Alonge, and Okieimena, 2018), or harvested and moved to place where they can be used as substrate for planting crops or even sprayed out in the farm (Tilahun *et al*., 2021; Chisanga, *et al.*, 2020; Enagbonma and Babalola, 2019). López-Hernández (2023) and Subi and Sheela (2020) established that termite mounds contain some vital mineral salts especially P worthy for plant growth and development in areas where it is lacking according to the reviews carried on termite mounds by these authors.

Materials and Methods : **Sit survey** :Field visits, from which four termite mounds were chosen, broken up, sampled and labeled A to D and general soil (GS) randomly collected from site. Soil preparation standard methods were adopted and soil samples sent to ANALAB laboratory for physicochemical analysis.**Description of Termite mound soil**: Mounds A to D physical colours both in and outside revealed A: brown-blackish brown, B: gray brownish dark, C: grayish blackish brown, D: brownish gray. Soil ribbon formed were reviewed with Munsell-Color Chats Revision, revealed A-5YR ¾ dark reddish brown; B-7.5YR 4/6 strong brown; C-10YR ¾ dark yellowish brown and D-10YR 4/6-dark yellowish brown. **Soil analytical methods** :A pH test in 1:1 soil-water ratio method, measured with EQUIP-TRONICS digital pH meter, model number EQ-610. Nitrogen (N) estimated by Kjeldahl readiness tests and examination (AOAC, 1999). Soil P with the perchloric corrosive albimilation strategy technique by (Sommers and Nelson, 1972). While Phosphorus analyzed by using molybdenum blue calorimetry (Bray and Kurtz, 1945). Soil organic matter (SOM) measured with the potassium dichromate oxidation external heating method. Soil particle size carried out using the hydrometer method as described by (Gavlack, Horneck and Miller, 2005) and measured with a standard hydrometer, ASTM No.1. 152H-type with Bouyoucos scale in g L-1. Sand, silt and clay determination, followed basic method of (Gavlack *et al*., 2005). Exchangeable cations were extracted from the soil using an extracting solution (1 N NH4OAc) at pH 7.0. Extracted solutions analyzed by AA (atomic absorption) for the soil cations (Thomas, 1982); (Warnck and Brown, 1998). Contents then in 1/20 dilution (sample/distilled water) soil digests measured by reading absorbance on a UNICAM 969 Atomic Absorption Spectrophotometer at 766.5, 422.7 and 285.2 nm respectively. Sodium (Na) content in 1/20 diluted sample was determined by reading the absorbance at 248.3 nm (Okalebo, Gathna and Woomer, 2002). Exchangeable acidity (H++ Al3+) in the soil was extracted with 1M KCl (Thomas, 1982). The extract was titrated with 0.05M NaOH to a permanent pink end point using phenolphthalein indicator. NaOH used is equivalent to the total amount of exchangeable acidity (H++Al3+) in aliquot taken (Odu, Babalola, Udo, Ogunkunle, Bakare, and Adeoye, 1986). Additions of all exchangeable bases (Ca2+ + Mg2++ K+ +Na+) and total exchangeable acidity (H+ + Al3+) gave the effective cation exchangeable capacity (ECEC) (Juo,1978). Cupper (Cu) content extracted and determined through method Na-EDTA (Lindsay and Cox, 1985) extract filtered in a Whatman No.1 filter paper and amount of Cu clear aliquot part analyzed by means of a Perkin Elmer 3100 atomic absorption spectrometer. The determination of metal in the filtrate of digested soil samples was performed using Buck Model 205 flame Atomic Absorption Spectrophotometer. **Data analysis** : Data compiled from laboratory analyses carried out on the Termite mound soils parameters which was replicated three times and mean values were calculated using MS word Excel 2010. Individual mean values for each mound soil source tabulated along with composite soil sample from study site called general soil, GS.

Results and Discussion : The mean values of three replications of individual termite mound types are presented in Table 1. Each identified mound types were labeled A-D, while soil from the study site was labeled "general soil" GS. Soil usefulness and health status is determined by the abundance of elements and mineral salts available for plant use. Sometimes the physical appearances of plant growth and development often convey and suggest available nutrient present and relationship between plant and the soil. The ability of the plant to absorb the necessary nutrient for metabolic activities often lead to diminished supply of nutrient over a period of time and would necessitate replacement either through natural or artificial means. According to Minami (2020) topsoil was obviously formed in answer to issues like climate, biotic things, parent material, topography and time; besides soil depleted need support to achieve utmost performance for nutrient supply to plant (Schröder, Beckers, Daniels, Gnädinger, Maestri, Marmiroli, Mench, Millan, Obermeier, Oustriere, Persson, Poschenrieder, Rineau, Rutkowska, Schmid, Szulc, Witters and Sæbø, 2018); (Silver, Perez, Mayer, and Jones, 2021). Environment and its biodiversity safety is at present a daily discussion in most national and international conferences on the importance of environmental biodiversity and mans' survival in relation to food security. Use of inorganic fertilizer and pesticide have their own side effect and therefore the search for environmental friendly approach in food production method is sort at a time like this where climate change impact is steering at our faces in both the developed and developing nations of the world. Consequently, termite mound soils are evaluated to access its mineral elements, salts and organic content as a potential soil amendment material to breach the gape in the reduction of inorganic fertilizer causing pollution of the environment and high cost of procurement. **The pH :** Least and highest values of pH are from termite mounds A 4.01 and C 6.3, while the general soil GS pH is 4.13. The pH a master variable that influences all the activities within the soil and the plant uptake of necessary nutrients for growth and development (Neina, 2019). It plays a vital role in contributing to the acidic or alkalinity level at which nutrients could be available for plant uptake. Both extremes could be counterproductive for plants nutrient up take and would affect plant yield at harvest (Gentili, Ambrosini, Montagnani, Caronni and Citterio, 2018). Acidic pH values of the soil could be as a result of low level of organic matter, high clay and sand content in the samples, cultivation systems and this is a region notable with heavy annual rain fall in Nigeria which could impact on mineral salts, elements and organic matter (Zhang, Y, Wu, and Liu, 2019).

Nitrogen (%N); Phosphorus P (mg\Kg); Potassium K (cmol\kg): Nitrogen least and highest in mounds B % 0.053 and C % 0.083 compared with GS % 0.18 are lower. It indicates low nitrogen in the termite mounds. Nitrogen essential element required by every plant in respective of its ability to trap nitrogen from the air and accumulate to form nodule. The amount required differ from plant to plant but still very essential for physicochemical and biological actions.

Nitrogen deficiency is always visibly noted in plant performance through its leaves, stem growth/girth which may look unhealthy physically. Nitrogen used by plant for photosynthetic activities and biochemical functions, and for flower, and fruit/seed formation which is needed more at this stage of plant growth and development (Leghari, Wahocho, Laghari, HafeezHaghari, MustafaBhabhan, HussanTalpur, Bhutto, Wahocho, and Lashari, 2016); (Anas, Liao, Verma, Sarwar, Mahmood, Chen, Li, Zeng, Liu, and Li, 2020). In the absence of nitrogen, it brings about growth and development retardation (Chen, Cheng, Xu, Yang, and Yang, 2022) and in excess it becomes poisonous to plant, soil and environment (Anas *et al*., 2020). Hence the low levels of nitrogen mean values from the soils could be attributed to land use duration and soil degradation (Willy, Muyanga, Mbuvi, and Jayne, 2019). Phosphorus (P) another essential mineral element required also by plant for proper growth, development and responsible for several processes in seed germination to a fully grown up plant to flower and seed development (Uchida, 2000) ;(Malhotra, Pandey, and Sharma, 2018). The deficiency of P in the soil causes slow, weak, and stunted growth, delayed maturity and poor seed development (Meng, Chen, Wang, Huang, Ye, Chen, and Yang, 2021). The result revealed least and highest P are from mounds D 4.151 mg\Kg and C 19.527 mg\Kg (Table 1). When compared with GS soil 49.334 mg\Kg, the mound soils are quite lower. P could be supplied directly to the soil through application of inorganic and organic fertilizer. The decreased in P in the termite soil samples could be attributed to inadequate organic matter forming materials available within and around the termite mounds, the pH, clay mineral content, soil temperature and other nutrients etc. (Muindi, 2019). Potassium (K) present in termite mounds showed the least D 0.09 cmol/Kg and highest is between B 0.10 cmol/Kg and C 0.10 Cmol\Kg. The values obtained from the mounds are within the same level with GS soil 0.09cmol\Kg. K is needed for plant growth performance and hence very necessary for enzyme activation that promotes metabolism. It responsible for leaf stomata, electrical charges at Adenosine triphosphate (ATP) production, translocation of photosynthetic sugar to important growth parts and fight diseases as well (Sardans and Peñuelas, 2021; Hasanuzzaman, Bhuyan, Nahar, Hossain, Mahmud, Hossen, Masud, Moumita, and Fujita, 2018). K deficiency in soil causes chlorosis along leaf edges, delay growth and decline in seed and fruit quantity (Thornburg, Liu, Li, Xue, Wang, Li, Fontana, Davis, Liu, Zhang, Zhang, Liu, and Pan, 2020) ;(Fontana, Wang, Sun, Xue, Li, Liu, Davis, Thornburg, Zhang, Zhang, and Pan, 2020). The values of which is low could be as a result of long term agricultural activities in the site sampled, soil pH (Al-Busaidi, Janke, Menezes-Blackburn, and Khan, 2022), study is characterized with high rainfall and humidity (Sardans and Peñuelas, 2021; Goulding, Murrell, Mikkelsen, Rosolem, Johnston, Wang, and Alfaro, 2021).

Organic carbon (%OC): Organic carbon (OC) combination of dead materials of plants, insects, animals, microorganisms and water. It improves soil health, water retention, nutrient dynamics, reduce and leaching. Lack of OC in soil reveals its degraded nature either due long term cultivation of the land, soil erosion, leaching and high rain fall which washes away available soil nutrients. Least and highest OC present in mounds A and C %0.48 and %0.94 respectively, compared with GS %2.16 which was higher. The reduction in OC from the mounds soil could be attributed to unavailability biodegradable materials within and around the mounds (Celestina, 2019). However, the increase in OC in GS soil, could be from dead vegetative covers and other farming activities that occurs in the site (Yang, Hu, and Shu, 2021). **Calcium (Ca), Magnesium (Mg), Sodium (Na), Aluminum (Al) :** Calcium (Ca) required for proper performance of plant root system, fruit and seed formation. An integral part of cell walls, and structures of the stems both physical and internal and hence protect the plant from pest and disease. Ca least and highest value are B 0.96 and C 5.09 Cmol\Kg respectively. B is slightly near to GS of 1.06 cmol\Kg. Ca mean values increase could be attributed to parent earth crust materials and ability of termite dig deep earth crust and move huge soil to the top most part in the course of building mound. According to Apori, *et al*., (2020) termite influenced nutrient recycling through organic matter decomposition and nutrient recycling rates. Ca harmful to plant when excess in soil and accessible for plant uptake causing decline in most biological, chemical and physiological developmental stages in plant (Weng, Li, Ren, Zhou, Zhu, Zhang, and Liu, 2022); though deficiency cause growth deformation of some vital plant parts. Magnesium (Mg) essential nutrient for biochemical reactions in plant for example chlorophyll production, utilization of photoassimulates and other activities in plant cell. Its deficiency in soil yields stunted plant growth and development, and poor quality yield. Mg least and highest mean values are mounds D 0.200 and C 0.630 cmol/Kg respectively. Mound C with 0.630 cmol/Kg was higher than GS 0.260 Cmol\Kg. Whereas A, B and D, somewhat lower than GS 0.260 cmol\Kg. Mg increase in mound C might be result of some plant debris incorporated during mound establishment at onset which decayed and became compost, and sometimes surrounding plants bodies chopped up into miniature sizes. It is likely artificial fertilizer application could have been used for plant growth and water carried to base of mounds due to attendant high rainfall in the region (Guo and Chen, 2022). Sodium (Na) required for functional growth in many plant species. It contributes to inorganic and organic neutralization of anions and macromolecules, pH and cell osmotic pressure. However, it could cause damage to roots of plant in excess through toxicity to sensitive plant parts.Sodium analysis revealed mounds A-D as 0.28, 0.20, 0.29 and 0.28 cmol/Kg respectively within same level and slightly difference from C, by 0.01 cmol\Kg. Compare with GS, no significant difference. According to Alengebawy, Abdelkhalek, Qureshi, and Wang, (2021); Das, Devi, Venu, and Borah, (2023); Kaur and Sinha, (2019), all agricultural soils contain Na for the reason of irrigation water, runoff water, pesticide, fertilizer and heavy metals from these sources. This could have contributed for closeness of means for Na present both termite mounds and general soil, GS. Aluminum (Al) in soil through earth crust and though of no importance for plant performance. Yet, presence in soil could be more sensed at pH below 5, soluble and available to plants. Al effect on plant might be due to concentration, time of exposure, plant varieties, developmental stages and plant growth condition (Ofoe, Thomas, Asiedu, Wang-Pruski, Fofana, and Abbey,2023). In recent review work by Bojórquez-Quintal, Escalante-Magaña, Echevarría-Machado, and MartínezEstévez, (2017) revealed aluminum to encourage root growth, better nutrient uptake, enzyme activity which depends on pH amongst elements which combine aluminum to form other species of aluminum. Mound C 0.65 and B 2.30 cmol/Kg were least and highest respectively. Although, least mean value of Al in mound C 0.65 cmol/Kg is smaller compared with GS 1.70 cmol\Kg. Values could be connected to pH influence on mounds soil which was between 4.01 and 6.3, which according to Ofoe, *et al*., (2023); Gunasekera and Silva. (2020); Kisnierinene and Lepeikaite (2015) are most susceptible to aluminum toxicity due to decreasing acidity which limits agricultural plant production.

Electrical conductivity (EC) expresses the ability of soil to conduct current expressed in µS\cm. It measures water-soluble salts in the soil, an indication of soil salinity. EC of soil could be influenced by soluble salts, clay and minerals present, soil water, bulk density, organic matter and soil temperature (Okoror and Amanze 2024) ;(Kim and Park, 2024); and where the value seems moderately high is an indication of the health position of the soil leading to increased plant yield, while excessively high value is an indication of salinity problem (Ngoune and Shelton 2020).

EC 53.0 µS/cm and 217 µS/cm for B and C least and highest respectively. Mound C 217 µS/cm was higher than GS 144 µS/cm electrical conductivity. However, there appears not to be a general agreeable EC for soil due to location, clay content, temperature, high rainfall, sodium/salt content, water content and water used for irrigation (Okoror and Amanze ,2024). Thus, high mean value obtained from C could be attributed to the high mean values of Mn, Fe, P and fertilizer washed down along with water which combines and increases the amount of salt in the solution.

Soil acidity measures level of acidity or alkalinity of soil as at the time soil was evaluated. It is determined through pH measurement which defines the level of hydrogen ions concentrations available in soil. Soil with high acid level affects availability of some essential nutrients like phosphorus and molybdenum. This encourages presence of other chemicals like aluminum and manganese, which affect plant performance. However, soil with high level of alkalinity reduce water and nutrient absorption, enzyme activity and ion toxicity resulting in suppressed plant growth and even death (Yang, Xu, Tang, Jin, and Yang, 2024); (Qiu, 2022; Gentili, *et al*., 2018). C 2.65 and D 12.80 cmol/Kg represent least and highest acidity mean values respectively. Comparing least C 2.65 with GS 8.80cmol/K highest revealed a great difference by 6.15 cmol/Kg. Nevertheless, the rest of mounds A, B and D are close to GS 8.80 cmol\Kg and nearness to each other. Mound C with lowest acidity has higher values of some parameters evaluated for example: pH 6.3; EC 217 µS/cm; %OC 0.94; P 19.5 mg\Kg; Ca 5.9 cmol\Kg; Mg 0.63 cmol\Kg; Mn 45.32 mg/Kg; Fe 51 mg/Kg; Sand %72.66. These could have impacted on acidity as soil pH plays a great part in nutrients availability, accessibility and microbial activities in soil (Mthimkhulu, Neil Miles, Titshall, and Dlamini, 2019). Effective cation exchange capacity (ECEC) gives information about total amount of exchangeable cations, which are basically bases (sodium, potassium, calcium and magnesium in non-acidic soils and bases plus aluminum. Soils of different combinations of sand, silt, clay and organic matter are able to hold essential elements and make available for plant use. It presents relationship between soil minerals and organic matter available in soil and made available for plant use without been washed away (Yang, *et al*., (2024); (Ćirić, Prekop, Šeremešić, Vojnov, Pejić, Radovanović, and Marinković, 2023); (Solly, Weber, Zimmermann, Walthert, Hagedorn, and Schmidt, 2020). ECEC is essential and discloses its ability to maintain fertility through colloids binding effect. ECEC least C 8.79 cmol/Kg and highest D 16.23 cmol/Kg respectively. Apart from C with 8.79 cmol\Kg; A, B, and D were close to GS 11.95 cmol\Kg. High mean values of ECEC could be attributed to high clay content in mounds A – D than GS less amount of clay (Rakhsh, Golchin, Al Agha, Alamdari, 2017).

Manganese (Mn), Iron (Fe), Copper (Cu) Zinc (Zn) : Manganese (Mn) micronutrient essential for plant growth and development. Mn needed for synthesis of several plant cells, example in photosynthesis and lots of physicochemical in plant and resistance to root pathogens. Its absence in the soil would impact on plant yield due to photosynthetic reduction (Alejandro, Höller, Meier, and Peiter, 2020). Laboratory analysis revealed least and highest of Mn as B 4.33 and C 45.32 mg\Kg respectively. C was higher than GS 28.76 mg\kg. While, A, B and D were by far below GS 28.76 mg\Kg. C increase could have come from earth crust, termites' ability to dig deep down, move soil for mound building and coupled with redox reaction, bearing in mind pH and organic content of the mound (Salvucci, Rafael, Cocco, Cardelli, Camponi, Serrani, Feniasse, Weindorf, and Corti, 2023), (Table 1). Iron (Fe)vital micronutrient for plant performance, responsible for enzymatic reactions involving electron transport chain, green pigment synthesis and chloroplast structure and function, and stimuluses availability of other metallic minerals in soil. Fe in soil depends on pH, organic matter, moisture, temperature and cooperating elements. Its unreachability is due to cold, high calcium content poorly drained or waterlogged soil. Fe unreachable affect root health, encourages root decay and notable pests that would impact on plant yield (Porkodi, Ramamoorthi, and David Israel Mansingh, 2023). Fe least and highest mean values are B 23.96 mg\Kg and C 51.20 mg\Kg respectively. A to D were lower than GS 57.68 mg\Kg. However, mounds A, B and D were of same range; but increase in C could be attributed on impact of pH, organic content, moisture and interaction with other elements like Fe oxides (Li, Hu, Li, and Li, 2023); (Schmidt, *et al*., 2020). Copper (Cu) micronutrient necessary for many enzymatic actions in plant for example chlorophyll and seed production. Cu could be present in environment through anthropogenic activities like antifungal agent application in farm practices. Excess Cu in environment could be basis of phytotoxicity causing distortion in plant biochemical processes. Lack of Cu could intensify vulnerability to diseases which could cause serious impact on small plants that produces small grain plants and change essential functions in plant metabolism (Kumar, Pandita, Sidhu, Sharma, Khanna, Kaur, Bali, and Setia, 2021). Cu least and highest values D 0.78 mg\Kg and C 1.19 mg\Kg respectively; C 1.19 mg\Kg is highest compared with GS 1.42 mg\Kg less. A, B and D are close in mean value to each other hence relationship in Cu content. Cu mean values compared with the permissible Cu value for soil which is 10 mg\Kg (WHO, 1996) are significantly small and termite soils are safe with Cu present in them. Clay, silt, sand, mineral elements, mineral salts and organic materials, gases, water and microorganisms in different proportions constituted soil. These proportions make up different types of agricultural soil for plant growth and development. Evaluated termite mound soils revealed elements, mineral salts, organic content, pH, ECEC, acidity, electrical conductivity (EC), clay; sand and silt slightly different from the GS from test site.

Conclusion and Recommendations

Termites presence in an ecosystems have both positive and negative impact. Positively, contributes to soil improvement through breakdown of plants and move enormous soil up, while negatively destroys crops, woods and other farm produce causing great lost. Nevertheless, proper integrated pest management (IPM) options would reduce damages and increase its potential benefits to agroecosystems, environmental biodiversity and man when used also soil amendment.

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Table 1: Parameters evaluated from individual termite mound and general soil(GS)

Parameters	Mounds				General soil
	A	B	C	D	GS
pH	4.01	4.12	6.30	4.70	4.13
EC((µS/cm)	68.00	53.00	217.00	57.00	144.00
%N	0.06	0.05	0.08	0.07	0.19
%OC	0.48	0.54	0.94	0.66	2.16
P(mg\Kg)	6.46	4.74	19.53	4.15	49.33
Ca(cmol\kg)	1.18	0.96	5.09	1.11	1.06
Mg(cmol\Kg)	0.21	0.21	0.63	0.20	0.26
K(cmol\Kg)	0.10	0.11	0.11	0.09	0.10
Na(cmol\Kg)	0.28	0.28	0.29	0.28	0.29
Acidity(cmol\Kg)	10.00	11.90	2.65	12.80	8.80
Al(cmol\Kg)	1.65	2.30	0.65	1.95	1.70
ECEC(cmol\Kg)	13.21	15.55	8.79	16.23	11.95
Mn(mg\Kg)	5.82	4.33	45.32	6.83	28.76
Fe(mg\Kg)	27.62	23.96	51.20	26.04	57.68
Cu(mg\Kg)	0.90	0.81	1.19	0.78	1.42
Zn(mg\Kg)	20.21	5.35	9.93	9.50	10.68
%Clay	31.70	33.70	17.70	33.70	7.70
%Silt	11.64	7.64	9.64	5.64	9.64
%Sand	55.66	58.66	72.66	60.66	82.66

Plate 1: Inside view of individual termite mound

Mound A

Mound B

Mound C

Mound D

Plate 2: Outside view of individual termite mound colour

Mound A

Mound B

Mound C

Mound D

Table 2: Termite mound soil color determination with Munsell-Color Charts 2009 Revision.

Mound A(Soil)	**Mound B(Soil)**	**Mound C(Soil)**	**Mound D(Soil)**
5YR ¾ dark reddish brown	7.5YR 4/6 strong brown	10YR ¾ dark yellowish brown	10YR 4/6-dark yellowish brown.