



EFFECTS OF TERMITE INFESTATION ON SOIL PHYSIO – CHEMICAL PROPERTIES IN SEMI – ARID TROPICS

*¹Abdallah, Y., ¹Jibrin, M., ²Ibrahim, I. I. and ³Tijjani, A.

¹Sa'adu Zungur University, Bauchi, Bauchi State, Nigeria.

²Federal College of Forest Resources Management, Maiduguri, Borno State, Nigeria.

³Abubakar Tafawa Balewa University, Bauchi, Bauchi State, Nigeria

*Corresponding Author's Email: abdallawa@gmail.com, GSM: 08036111755

ABSTRACT

The research was carried out to determine the effect of termite infestation on physio-chemical properties of soil at Futuk, in Alkaleri L.G A of Bauchi state which lies between latitude 9.3⁰ and 12.3⁰ N of the Equator and longitudes 8.3⁰ and 11.08⁰ E of the Greenwich Meridian. Stratified random sampling technique was used to collect a total of twenty-five surface (0 – 15cm) soil samples from termites infested soil and a total of nine sample from termites infested sub-soil surface (35 – 50cm). Another twenty-five samples were obtained from surface soil and nine from sub-surface of non-termite infested area, making a total of sixty-eight soils samples covering both termites infested and non-infested areas. Standard procedure was followed in the laboratory for physio-chemical properties analysis of the soil. Data collected were analysed using descriptive statistics with simple percentage. The result indicates that, the organic matter content of the termite infested soils ranges between very low to medium while that of soils without termite's infestation ranges between very low and low. Particle size analysis shows that soils not infested by the activity of termites are mainly loamy sand and sand as the dominant class. The pH of the termite infested soils is higher than that found for the surrounding soils without termites' activity. The result of the chemical analysis confirmed that, there is a higher amount of N, P, K and CEC in the termite infested soils compared to the figures observed from the soils without termites. Conclusively the activities of termites in the research area have led to an increase in organic matter content (OC), available phosphorus (AP), total nitrogen (TN), and soil PH.

Keywords: Termites, Soil, Properties, Infestation, Organic, Carbon

INTRODUCTION

The soil system plays a pivotal role in the major geochemical cycles. Soils have the capacity to assimilate great quantities of organic waste, turning it into beneficial humus and converting the mineral nutrients in the wastes to forms that can be utilized by plants and animals (Brady and Weil, 2002). Soils supply plants with inorganic nutrients in the form of dissolved ions. These minerals include such metallic elements as potassium, calcium, iron and copper as well as such non-metallic elements as nitrogen, sulphur, phosphorus and boron. From the food chain, humans and other animals usually obtain the minerals they need (Brady and Weil, 2002). A fundamental role of soil in supporting plant growth is to provide a continuing supply of dissolved mineral nutrients in amount and proportions appropriate to plant growth (Brady and Weil, 2002). The productive capacity of soils depends on many factors, including the flora and fauna. Soil fauna, especially earthworms and termites, are important components of the soil ecosystem. An understanding of the effects of soil micro fauna and their effects on the ecosystem is very important to soil quality and crop production (Brady and Weil, 2002). The termite's ability to adapt to arid environment has led them to fill the important role of decomposition where common decomposes such a bacteria and fungi cannot function. Australia for example offered an ideal place to study the effects of dry environments on termites because of the low precipitation and elevated heat levels of desert ecology and savanna (Ratcliff *et al*, 1952). Termites are social insects of the order isoptera with about 3,000 known species of which 75% are classified as soil feeding termites. The diet of soil feeding termites consists of non-cellular organic material mixed with clay minerals. Their gut is formed by five compartments that present rising gradients of pH up to 12.5 and different status of oxygen and hydrogen (Breuning-Madsen *et al*, 2005). Termites consume roughly 20% by weight of



litter fall and about 10% of annual primary production in the tropical wet forest of Ghana (Quansah *et al.*, 2022) and are therefore very important agents in nutrients recycling (Asigbaase *et al.*, 2023).

Soil-feeding termites transport soil particles for mound building and such process can affect soil formation and characteristics. It is evidenced that termites modify soil characteristics due to great volume of soil transported for mound construction which promotes a strong pedo-bioperturbation and affects nutrient cycling and soil physical properties. The modification of soil profiles activity depends on the fact that termites remove soil from various depths and bring it to the surface in form of covered runways or mounds from which it is distributed by water and wind erosion (Martin, 2000). Furthermore, the wood-eating termites are important agents, moving soil materials from the deeper soil horizons to the dead wood on surface of the forest floor. When the wood has been eaten and partly replaced with soil material by the termites, the termites leave the place and the soil material is later incorporated in the top soil. Termites are known to disturb soil materials (Kaschuk *et al.*, 2006) because they collect particles from different soil depths deposit main in mounds. Hence the various contents of the soil can be different from those of the adjacent soils. This perturbation may have impacts on soil variation. Bauchi State is one of the states in Nigeria where termites infestation in soil has become prevalent, and tremendously felt. Extensive areas of agricultural and non-agricultural lands are affected. Almost all kinds of crop are affected. Farmers always complain through various extension service outlets, about the menace, devastation and destruction of termites on agricultural crops. The disturbance impacted on soils is also a matter of great concern. Soil perturbation will surely have effects on soil variation and precision agriculture. Although, it is of immense importance to note that termites contribute to the breakdown of organic material in or at the surface of soil (Brady and Weil, 2002). High soil organic matter content and favorable soil structure depend on the activity and species diversity of soil fauna. The activity of soil macro fauna (e.g. termites and earthworms) is critical to the sustainable maintenance of favourable soil structure and mineral cycling (Lal, 2008). Unfortunately, no work has been done on the effects of termites infestation on soil properties variation in the study area. To fill this research gap, the study was carried out to determine the effects of termite's infestation on soil physio-chemical properties in the study area.

MATERIALS AND METHODS

The Study Area

The research was carried out at Futuk in Alkaleri LGA of Bauchi State. The area lies between latitude 9.3° and 12.3° N of the Equator and longitudes 8.3° and 11.08° E of the Greenwich Meridian. It is bordered by seven states: Kano and Jigawa to the North, Taraba and Plateau to the south, Gombe and Yobe to the east and Kaduna to the west. It occupies a total area of 549,259 01/sq kilometers representing about 5.3 percent of the land mass of Nigeria. The research area spans two vegetation zones namely the Sudan Savannah and the Sahel Savannah. Rainfall in the state ranges between 1000mm and 1300mm per annum in the Sahel Savannah. Effective rainy season starts from mid-May or sometimes in early June and ends late October. The dry season starts in October and ends in May. This period is characterized by dryness and presence of harmattan-dust and haze, especially between December and March. The beginning and the end of rainy season in the state are seldom abrupt. Instead, it is usually preceded by a succession of isolated showers of uncertain intensity with intervening dry periods of varying degrees. Rainfall variability increased northwards. It is highest in May and decreases as the rainy season progress. Relative humidity ranges from about 12 percent in February to about 68 percent in August. At the beginning of the rainy season, relative humidity is about 37 percent.

Data Collection

A reconnaissance survey of the study area was carried out by meticulously selecting and identifying termites infested soils (farm lands) having termites' mounds with termites' presence on plants residues and surrounding trees. The specific area evaluated for the study is located at 3km away from Alkaleri town. Situated along Futuk road with fairly flat agricultural farmlands that are cultivated to millet, sorghum, maize and cowpea in between plant stands. This area has high infestation of termites, with termites' infestation symptoms on plant residues after the previous farming season's harvest, and also there are presence of quite a number of termites mounds within and around the study area.



The soils of the study area are severely infested by termites. There is remarkable evidence of termites' infestation as a result of cursory observation of the crop residues with apparent symptoms of termites' infestation decaying and decomposing crop residues in the field. Also, in the area observed there are (4) big termitarium (termite mounds) about 50m apart perpendicularly located.

Random Sampling

Soil samples were taken in the field using these techniques by measuring total area of 25×25m. The area was totally divided into 25 smaller blocks and each measuring 5×5m and soil samples taken by stratified random sampling technique. This was done by taken samples in each smaller blocks by throwing an object four times, and wherever it landed each time, soils samples were collected in the exact position and mix together with soils collected at 4 angles of 5×5m block, and kept in polythene bag as one sample. The idea is to give an equal chance of representation in the whole sample during analysis.

A total of twenty-five surface (0 – 15cm) soil samples from the termites infested soil surface, and a total of nine soil sample from the termites infested sub-soil surface (35 – 50cm). This same technique was also applied in the collection of soil samples from termites non-infested area, making a total of sixty-eight soils samples covering both termites infested and non-infested areas.

Laboratory Analysis

Particle Size: This was determined by the hydrometer method (Black and Okwakol, 1997) in preference to pipette method because of the large number of samples that were involved.

Soil pH (Water and CaCl₂ Solution): The pH of the soils was potentiometrically measured in suspension of 1:2:5 (soil: liquid: mixture) measurements were both in water and 1M CaCl₂ solution because the difference between the two values could give an idea about the soil potential or reserve acidity.

Organic Carbon: The Walkley-black wet oxidation procedure (Black and Okwakol, 1997) was followed in determining the matter content. For the conversion to organic matter factor 1.7.2 was used. Determination of organic matter was necessary because organic matter has been found to be influenced by termites activities. In turn organic matter always influences the amount of nutrients such as nitrogen, potassium, calcium and phosphorus among others.

Total Nitrogen (TN): Total Nitrogen content was determined using the classic Keldahl method followed by steam distillation (Bremner, 1965). It involved the digestion of the soil with sulphuric acid (H₂SO₄) and hydrogen peroxide whereby nitrogen could be converted to ammonia sulphate and the ammonia evolved was titrated with standard acid. The determination was made because total nitrogen (N) is one of the parameters usually used in assessing the nutrient status of soil and fertility of soil in general.

Available Phosphorus (AP): Available phosphorus was determined using Bray and Kurtz (1945) No. 1 method. The method has been found to be most suitable in the acid soils characteristics. Available phosphorus content is necessary because they are used in measuring soil fertility status.

Exchangeable Bases (Ca, Mg, K, Na): Exchangeable cations were determined by leaching the soils with ammonia acetate at pH 7.0 potassium and sodium in the leachate were determined by flame photometric method while calcium and magnesium were determined by atomic absorption spectrometry.

Exchangeable Acidity: The exchangeable acidity was determined by KCl method (Page *et al*, 1982) while the exchangeable acidity determination was performed by percolating soil with 1M KCl solution. The acidity in the percolate was then measured by titrating it with 0.025m NaOH.

This determination is necessary because it is used to determine the effective cation exchange capacity (ECEC) which is defined as the sum of bases plus exchangeable acidity (Al^{3++H}).

Data Analysis

The statistical analysis used was aimed at assessing and evaluating the differences in soil properties and nutrient status between the termites' infested soils in the agricultural farm lands of the research area and termites non-infested farm lands. Statistical Package for Social Science (SPSS 21) was used to analyze the result using descriptive statistics of simple percentage.



RESULTS AND DISCUSSION

Soil Texture

Soil analysis presented in Table 1 shows that the sand contents of the soil are generally high. This is because the soils are mainly underlain by acolian (or wind-drifted) materials (Abdallah and Jibrin, 2020). According to Brady and Weil (2002) when the sand contents exceed 75% in a sample, the soil is a sandy one. Particle size analysis of both termite infested soils and the surrounding soils not infested indicates that the percentage of sand in all samples exceed 75%. Hence, the soils of the study area are sandy in nature. The implication is that there may have high rates of infiltration and leaching. This may lead to low base status. The results of the particle size analysis of termite infested soils indicate that sand percentage ranges from 72 to 94% with a mean value of 86.06%, clay percentage ranges from 4 to 22% with a mean value of 8.82%, silt percentage ranges between 2 and 46% with a mean value of 6.35%. Particle size analysis also indicates that soils with termite infestation are mainly coarse-textured and the dominant textural classes are mostly loamy sand. The result of particle size analysis of soils not infested by the activity of termites indicate that sand percentage ranges between 80% and 94% with a mean value of 89.12%, clay percentage of the soils not infested by termites ranges between 4 – 18% with a mean value of 7.18% while silt percentage in the termite non infested soil ranges between 2 – 8% with a mean value of 3.71%. Particle size analysis shows that soils not infested by the activity of termites are mainly loamy sand and sand as the dominant class. The difference in the textural class of the termite infested soils and soils without termites infestation clearly demonstrate the significant role of termite in disturbing the soils and also in the addition of dead plant material and thereby nutrient recycling (Wagner *et al.*, 1991).

Organic Matter Content (O.C)

The result of the chemical analysis shows that organic matter content (OC) of the termite infested soils ranges between 0.060% and 0.720% with a mean value of 0.299% (Table 1) and that of the surrounding soils without the activity of termite's ranges between 0.10 and 0.29% with a mean value of 0.174% (Table 1). Hence, this indicates that the organic matter content of the termite infested soils ranges between very low to medium while that of soils without termite's infestation ranges between very low and low (Mullins *et al.*, 2021). The activities of termites were able to raise the organic matter content of the infested soils slightly above that of the surrounding soils without termites infestations. This indicates that termites often act as a primary decomposer in dry climates where there is no enough moisture for organisms like fungi, earthworm, micro-bacteria and beetles (Jembere *et al.*, 2017). The low level of organic matter can be attributed to poor soil management practices, bush burning, overgrazing and the removal of crop residues. Olowolafe and Dung (2000) have obtained a similar result for soil on the Jos Plateau.

Organic content plays a significant role in agricultural production, it supplies plant nutrients, enhances cation exchange capacity, improves soil water retention capacity, and enhancement of soil aggregate stability. Organic matter content also improves soil structure by providing good soil aeration, permeability, and increasing rate of infiltration and water holding capacity. The organic matter of both soils is very low, with termites infested soils having a mean value of 0.298% and soils without termite infestation having a mean value of 0.741% (Ilaco, 1985). This results showed that there is need for continuous addition of organic matter, through adoption of several agronomic and good management practice by addition of organic fertilizers (green manure), incorporation of crop residues in the soils, increasing humus content, addition of poultry droppings, and cow-dung. When organic matter declines, plant nutrients such as nitrogen and phosphorus are mostly at risk ((Mullins *et al.*, 2021).

Soil Reaction (pH)

pH (H₂O): The result of the chemical analysis shows that pH (H₂O) of the termite infested soils had a mean value of 6.30 (Table 1) and that of the surrounding soils without termites' activity with a mean value of 5.41 (Table 1). The pH (H₂O) of the termite infested soils is higher than that found for the surrounding soils without termites' activity. The pH (H₂O) of the termite infested soils ranges between very strongly acidic and very slightly acidic while that of the surrounding soils not infested by termite ranges between strongly acidic to slightly acidic (Ilaco, 1985). Soil pH is an important property that determines the availability of plants nutrients. The soils evaluated in the research area for the termite



infested soils are generally slightly acidic with pH ranging between 6.1 and 6.5 while the soils without termites' infestation are moderately acidic with pH value ranging between 5.6 and 6.0 (Ilaco, 1985).

Most of the tropical crops perform best under the pH values that ranges between 5.0 – 6.5 (Brady and Weil 2002); most of agricultural crops such as millet, maize cowpea, soybeans cultivated in the research area have their pH values in which they perform optimally with sound agronomic and good management practice within these pH ranges. The sources of hydrogen ions in the soils that causes acidity are carbonic acid (when carbon-dioxide gas from soil air dissolves in water thus weak acid is formed), precipitation (rain, snow, fog and dust) among others (Brady and Weil, 2002). At pH levels below 4.0 – 4.5 the H⁺ ions themselves are of sufficient concentration to be toxic to plants mainly by damaging the root membranes.

Total Nitrogen (TN)

The result of chemical analysis shows that the total nitrogen content of termites infested soils ranges between 0.193% and 0.530% with a mean value of 0.239% (Table 1) while the total nitrogen content of soils not infested by the activity of termite ranges between 0.19% and 0.26% with a mean value of 0.228% (Table 1). The total nitrogen of both soils ranges between very low and low levels of nitrogen. High temperature, as often occurs on the surface of the soil in tropical areas favors the volatilization of organic matter and leaching in the drainage water may account for the low levels (Brady and Weil, 2002). A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients. Plants respond quickly to increased availability of nitrogen their leaves turning deep green in color. Nitrogen increases the plumpness of cereal grains, the protein content of both seeds and foliage (Brady and Weil, 2002).

Nitrogen is also essential for plant growth as it is a constituent of all proteins and hence of all protoplasm. It is generally taken up by plants either as a ammonium or nitrate ions but the absorbed nitrate is rapidly released probably to ammonium ions and some of the carbohydrates synthesized in the leaves are converted into amino acids mainly in the green leaf itself. Hence as the level of nitrogen supply increases compared to other nutrients, the extra protein produced allows the plant leaves to grow larger and hence to a larger surface available for photosynthesis. Nitrogen increases the size of the cells and gives them a thinner wall, hence makes leaves more succulent. Excessive amounts of nitrogen give leaves with such large thin-walled cells that they are readily attracted by insects and harmed by harsh weather such as droughts and frosts. The deficiency of nitrogen in soils are responsible for stunted growth and pale yellowish green color (chlorosis) (Tuley & Mary, 1975) and plant growing under this type of condition are highly affected, which results in low yield and poor growth quality. A very low nitrogen supply also gives leaves small cells and thick walls and the leaves in consequence become harsh and fibrous.

Available Phosphorus (P)

The result of the chemical analysis shows that available phosphorus of the termite infested soils ranges between 4.48ppm and 50.40ppm with a mean value of 14.93ppm (Table 3a) and available phosphorus for soils not infested by termite activities ranges between 1.96ppm and 7.84ppm with a mean value of 4.63ppm (Table 1). The result of the chemical analysis confirms that there is a higher amount of available phosphorus in the termite infested soils compared to the figures observed from the soils without termites. The available phosphorus of the termite infested soils ranges between low and high values while that of the soils without termite infestation is low (Ilaco, 1985). The result shows that the phosphorus level of both infested and non-infested soils are low which requires addition of phosphorus during crop production on both sides. Plants take up their phosphorus almost exclusively as inorganic phosphate ions probably principally as the H₂PO₄ for they may take this up more easily than the HPO₃ other phosphate besides ortho-phosphate act as phosphate fertilizers as for example meta and pyro-phosphates, it is probable that these anions are hydrolyzed to ortho-phosphate before being absorbed. Plants are however relatively inefficient users of phosphates in the fields for rarely more than 20 – 30 of the amount supplied as fertilizer is taken up.

Exchangeable Bases (Ca, Mg, K, Na)

Calcium (Ca): The result of chemical analysis shows that calcium content of the termite infested soils ranges between 1.60cmol/kg-1 and 5.20cmol/kg-1 with a mean value of 2.850cmol/kg-1 (Table 1) and



calcium content of the surrounding soils without termite infestation ranges between 1.20cmol/kg-1 and 5.00cmol/kg-1 with a mean value of 2.238cmol/kg-1 (Table 1). The Calcium content of the termite infested soils ranges between very low and medium and that of the surrounding soils without termites ranges between low to medium (Ilaco, 1985). The result indicates that the activities of termites could not raise the calcium content above that of the surrounding soils without termites infestation. Calcium appears to be essential for the growth of meristem and particularly for the proper growth and functioning of roots tips. It is also present as calcium pectate which is a constituent of the middle lamellae of the cell walls and possibly for this reason, it tends to accumulate in the leaf. Calcium is also intimately involved with cell elongation and division, membrane permeability and the activation of several critical enzymes.

Magnesium (Mg): The result of chemical analysis shows that magnesium content of termite infested soils ranges between 0.83cmol/kg and 1.58cmol/kg with a mean value of 0.429cmol/kg-1 (see table 3a) while that of the surrounding soils without termites ranges between 0.17cmol/kg-1 and 2.16cmol/kg with a mean value of 0.685cmol/kg (Table 1). The magnesium content of the termite infested soils ranges between low and medium and that of the surrounding soils without termite infestation ranges between very low and medium (Anyango et al., 2020). The result confirms that there is a higher magnesium content in the termite infested soils as compared with that obtained from the surrounding soils without termites. **Sodium (Na):** The result of chemical analysis shows that sodium content of termite infested soils ranges between 0.35cmol/kg and 1.39cmol/kg-1 with a mean value of 0.636cmol/kg (Table 1) while that of the surrounding soils without termites' activities ranges between 0.61cmol/kg and 0.78cmol/kg with a mean value of 0.67cmol/kg (Table 1). The amount of Sodium contained in soils with termites is lower than that of soils without termites. The sodium content of soils infested by termites ranges between medium and high while that of the surrounding soils without termites is medium (Ilaco, 1985).

Sodium does not seem to be an essential element for any crop even for salt marsh plants yet certain crops grow better in the presence of available sodium supplies than in their absence, the sodium in these cases appearing to carry-out some functions that potassium usually fulfils. Sodium also increases the succulence of plants that is the amount of water held by unit dry weight of leaf tissue. This may be the reason why it appears to increase the drought resistance of these plants. Sodium helps certain plants to grow in a potassium deficient soil thus it prevents an accumulation of other cations that may be toxic to the plants. Crops can be divided into groups with respect to their relative needs of sodium compared to potassium, some need sodium for optimum growth, some benefit if available sodium is present, some can tolerate part of their potassium supply being replaced by sodium and some can make no use of sodium even if the potassium supply is restricted.

Cation Exchange Capacity (CEC)

The cation exchange capacity (CEC) of the termite infested soil ranges between 3.40 - 9.40cmol/kg-1 with a mean value of 5.24 (Table 1) and that of the surrounding soils not infested by the activity of termite ranges between 3.10cmol/kg-1 - 9.60cmol/kg-1 with a mean value of 4.46 cmol/kg (table 3b). There is only a slight variation in the CEC of both termite infested and non-infested soils.



Table 1: Physio – Chemical Properties of Infested and Un-infested Soil form the Study Area

Soil Property	Infested Soil	Un-infested Soil
Clay (%)	8.82	7.81
Silt (%)	6.35	3.71
Sand (%)	86.06	89.12
pH (H ₂ O)	6.30	5.40
pH (CaCl)	5.24	4.37
Organic Carbon (OC) %	0.30	0.17
Total Nitrogen (N) %	0.24	0.23
Available Phosphorous (P) ppm	14.93	4.62
Calcium (Ca)	2.85	2.24
Magnesium (Mg) cmol/kg	0.43	0.68
Potassium (K) cmol/kg	1.47	0.44
Sodium (Na) cmol/kg	0.64	0.67
Aluminium (Al) cmol/kg	0.26	0.39
Cation Exchange Capacity (CEC)	5.24	4.46



Table 2a: Physical and Chemical Properties of the Surface Soils with Termite Infestation (0 – 15cm)

Sample No.	Particle size distribution				pH					Chemical Properties					
	Clay	Silt	Sand	Tex. Class	H ₂ O	0.01m CaCl ₂	OC (%)	TN (%)	AP (ppm)	Ca (cmol/kg)	Mg (cmol/kg)	K (cmol/kg)	Na (cmol/kg)	H + Al (cmol/kg)	CEC (cmol/kg)
1	6	6	88	Loamy sand	6.0	5.0	0.254	0.210	7.70	2.8	0.103	0.21	0.52	0.40	4.60
2	8	6	89	Loamy sand	6.3	5.7	0.51	0.243	25.20	3.60	0.42	0.35	0.35	0.20	5.20
3	10	8	82	Loamy sand	6.8	6.2	0.41	0.210	19.4	5.00	0.17	1.74	0.44	0.20	7.60
4	8	6	86	Loamy sand	7.5	6.8	0.35	0.263	9.24	5.20	1.58	1.59	0.35	0.20	9.40
5	12	6	82	Sandy loam	6.9	6.4	0.72	0.193	20.44	3.20	0.75	0.31	0.44	0.20	5.30
6	14	4	82	Sandy loam	6.7	6.0	0.29	0.210	17.64	4.00	0.62	0.38	0.44	0.20	5.70
7	16	6	78	Sandy loam	6.4	5.6	0.37	0.193	16.10	1.80	0.93	1.23	0.44	0.20	4.80
8	20	4	76	Sandy loam	6.0	5.4	0.43	0.210	7.28	4.10	1.08	1.59	0.70	0.20	7.90
9	6	4	90	Sandy loam	6.2	5.6	0.39	0.210	50.40	3.40	0.91	0.45	0.52	0.80	6.30
10	8	6	86	Loamy sand	7.0	5.7	0.37	0.243	14.00	2.60	0.75	0.49	0.44	0.10	4.70
11	6	4	90	Sand	6.8	5.7	0.47	0.193	24.50	3.20	0.083	0.47	0.70	0.10	5.50
12	8	6	86	Loamy sand	6.3	3.8	0.23	0.210	20.16	2.60	0.17	0.34	0.61	0.40	4.30
13	22	6	72	Sandy clay loam	5.8	5.0	0.31	0.228	10.94	2.60	0.66	1.33	0.61	0.20	5.60
14	8	6	86	Loamy sand	6.7	5.7	0.33	0.243	25.20	2.40	0.49	1.13	0.61	0.40	5.20
Sample No.	8	4	88	Loamy sand	6.7	5.7	0.45	0.193	22.40	2.60	0.33	1.02	0.61	0.20	4.80



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16	8	4	88	Loamy sand	6.7	6.0	0.39	0.263	18.20	2.60	0.58	1.07	0.61	0.20	6.30
17	8	4	90	Sand	6.6	6.0	0.23	0.245	11.20	2.40	0.25	0.15	0.61	0.20	3.80
18	6	6	88	Loamy sand	6.3	5.5	0.63	0.210	11.20	2.80	0.49	0.27	0.61	0.20	4.60
19	6	6	88	Loamy sand	6.6	5.7	0.29	0.263	26.60	2.60	0.17	1.28	0.52	0.20	5.80
20	8	6	86	Loamy sand	6.5	5.7	0.19	0.193	15.96	2.60	0.17	1.13	0.61	0.20	4.90
21	10	6	84	Loamy sand	6.2	5.2	0.22	0.210	13.72	2.60	0.25	1.38	0.61	0.20	5.20
22	10	4	86	Loamy sand	6.4	5.2	0.33	0.243	15.12	3.60	0.17	1.13	0.61	0.40	6.50
23	6	4	90	Sand	6.4	5.3	0.23	0.243	11.90	2.20	0.33	0.40	0.96	0.20	4.70
24	10	6	84	Loamy sand	6.2	5.2	0.25	0.210	14.56	3.00	0.25	1.13	0.87	0.10	6.40
25	12	4	84	Loamy sand	6.1	4.1	0.25	0.193	16.86	2.20	0.17	0.47	0.78	0.10	4.30



CONCLUSION AND RECOMMENDATION

Based on the results of this research, the low level of nutrients status observed in the research area could be attributed to soil erosion apparently sheet and rill erosion in certain places. Removal of crop residues after harvesting operation season in season out, overgrazing and the influence of tropical climates particular in the study area. Termites play a very important role in decaying of dead plant materials and thereby nutrients circulation. They produce significant physical and chemical modification to topical and sub-tropical soils thus bringing variability in soil proprieties. The activities of termites also have an effect on the lateral and spatial variations of both physical and chemical properties of soils.

Termites are the most important decomposers in dry environment because of their ability to recycle nutrient, form soil, and retain moisture, and the activity on soil is also related to the effect of termites on the mobility of a number of soils element that are focus generally considered to be essential for the support or growth of all forms of life. Conclusively the activities of termites in the research area have led to an increase in organic matter content (OC), available phosphorus (AP), total nitrogen (TN), and soil PH. Government should encourage and provide adequate funding for further research in soils infested with termites with a view of utilizing the findings of the research to improve agricultural production.

Farmers should be enlightened through extension services outlet to adopt modern techniques and skills for soil and fertility management. Farmers should be encourage to incorporate crop residues on soil after harvesting operation, so that it will be prone to decomposition by termites and recycle to soils as nutrients. Government research center should engaged through adequate extension services in educating farmers; the role and significance of termites in modification of soils and improving agricultural production. Research centers should further initiate advance research in relation to termites activities on soils and crop production.

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