Growth and yields performance evaluation of maize raised on termite mound and surrounding soils

ABSTRACT

Termites are social insects and the mounds they develop are considered to be a waste. They fed on agricultural products and wooden structures and hence, they are considered to be destructive. The resultant mound soil is an agricultural soil which is rich in nutrients, but its usefulness in agriculture and construction industry had not been explored. Thus, the study evaluated the Growth and yields performance of maize raised on termite mound and surrounding soilsin Owo, Ondo State, Nigeria.Maize was cultivated on the termite and surrounding soils as well as on their 50-50% mixture by weight and the data of the yields of maize was subjected to statistical analysis using T test at 95% confidence level.The yields of maize cobs per stands for termite mound soil in plots 1, 4, 7 were 1,2,1; for the surrounding soil in plots 3,6,9 are 1,1,1 and for the mixture of the surrounding; and the termite mound soil were 3,2,2. The yields of maize cultivated on plots 1, 4, 7 (TMS); 2, 5, 8 (TMS+SRS); 3, 6, 9 (SRS) using t-distribution table were O.75<u<l .87 or l.31±O.56; l.68<u<2.92 or 2.30±0.62; 0.75<u<l.25 or 1.00±0.25.Mound soil had high nutrient content and high shear strength, thus it can be used for soil amendment. The findings from the study added to the knowledge database on soil fertility and can be adopted for similar work in any part of the country.

Keywords: *Growth, Maize, Termitarium, Soil, Yield*

INTRODUCTION

Termites mound soil is a type of soil naturally rich in soil nutrient naturally probably because of the activities of the termites in the termitarium while they were still alive. The soil formed by these social insect dominantly consist of clay along other soil fractions. In soils, clay dispensability is influenced by various properties, such as clay content, composition and surface charge characteristics, electrolyte composition and concentration, and organic matter content. The fraction of clay that disperse in water (water dispersible clay, WDC) controls a range of soil physical properties such as swelling, friability, hydraulic conductivity, surface scaling, crusting and susceptibility to erosion. The mounds formed by termites represent a large volume of material that will be added to the surrounding soils upon degradation, or when debris is spread over the soil surface during land clearing and preparation. Some of the soil properties that can be modified by termites' activities have great influence on structural features such as bulk density and structural stability (Jouquet*et al.*, 2011). The clay mineral fraction in termite mound is dominated by kaolinite with variable amounts of quartz, goethite and hemite; mica occurs in significant quantities (Mujinya*et al.*, 2013).Termites areendogenic exopterygotous insects that belong to the order Isopteran and it is one of the numerous organisms that inhabit the soil. They abound in Nigeria soils and they have been identified as common biological agents that produce significant physical and chemical modifications to tropical and subtropical soils. The abundance, composition and hence their impact on soil processes vary greatly depending on vegetation and land use pattern (Tabaldi*etal.*, 2012). The mounds they form are common features on agricultural landscape and came as product of the detritus materials they feed on (Semhi*et al.*, 2008). Depending on the species of termites and the surrounding environment, the mounds take on a variety of shapes and sizes. Construction of mounds from soil or mixture of soil and other materials within soil horizons will affect the physical and chemical characteristics of both the soil used for construction and the materials derived. During the period of inhabiting the mound, organics debris or living tissues collected, often over extensive foraging areas are transported to the mound for intense degradation by termite feeding on them. Termite activities in the soil therefore affect the nutrient and organic matter dynamics and structure of soil. Such changes in soil properties have profound influences on the productivity of the ecosystem via carbon sequestration, nutrient cycling and soil texture. Through their building and feeding activities, they play a key role in the dynamics of clays and soil organic matter in many tropical ecosystems (Jouquet*et al.,* 2005). Collection of soil materials caused by macrotermes termites is typically selective, whereby mound materials are more fine –grained than the surrounding soil (Abe *et al.*, 2009b). Macrotermes mounds are frequently enriched in soluble salts (Ammonium nitrate), exchangeable basic cations (Ca^{2+}, Mg^{2+} and K^{+}), and $CaCO_3$ compared to the adjacent topsoil (Abe *et al.,* 2009a; 2009b; Jouquet*et al.,* 2005; Mujinya*et al.,* 2010, 2011). Termites andants have been reported to play important roles in soil fertility in tropical ecosystems because of their impact on the soils they work on (Whiteford and Eldridge, 2013; Abitoy*et al.,* 2016).Despite the destructive habit of the termites on wooden structures, these social insects are beneficial to man and the environment and if proper preventive measures are adopted for their control, their advantages outweigh their disadvantage. The need for nutrient supplement at relatively low cost or at no cost will enable farmers to produce more since natural manure from termite mound soil will help to achieve this goal. Many people belief that termite is only a destructive creature and they have no benefits. This assumption has created lack of awareness to the public about the usefulness of termites.This study investigatedthe growth and yields of maize raised on termite mound and surrounding soils Owo, Ondo state environment.This study was carried out in Ondo

State because termite mound soils were found in abundance in many parts of the Local Government Area. There is a low exploration of this mound as soil amendment despite its high nutrient and organic matter content.

Materials and method

The Study Area

Owo, the headquarter of Owo Local Government is 48 Kilometers east of Akure, the capital of Ondo State, Nigeria and 400Km north – east of Lagos. The town spreads over an area of about 12 Km^2 as depicted in Figure 1. The population of Owo and its environs according to Nigeria census in 2006 was 222,262 andit is the fourth most thickly populated town in Ondo State (NPC, 2006). The town lies on latitude $7^{0}51^{1}$ N and longitude 5^{0} 35^{1}E. It is about 150 meters above sea level and the lands towards Ikare are hilly. Owo Local Government enjoys abundant rainfall of over 1,500mm annually and the South – westerly winds blows most of the year(Adew owose, 2017).

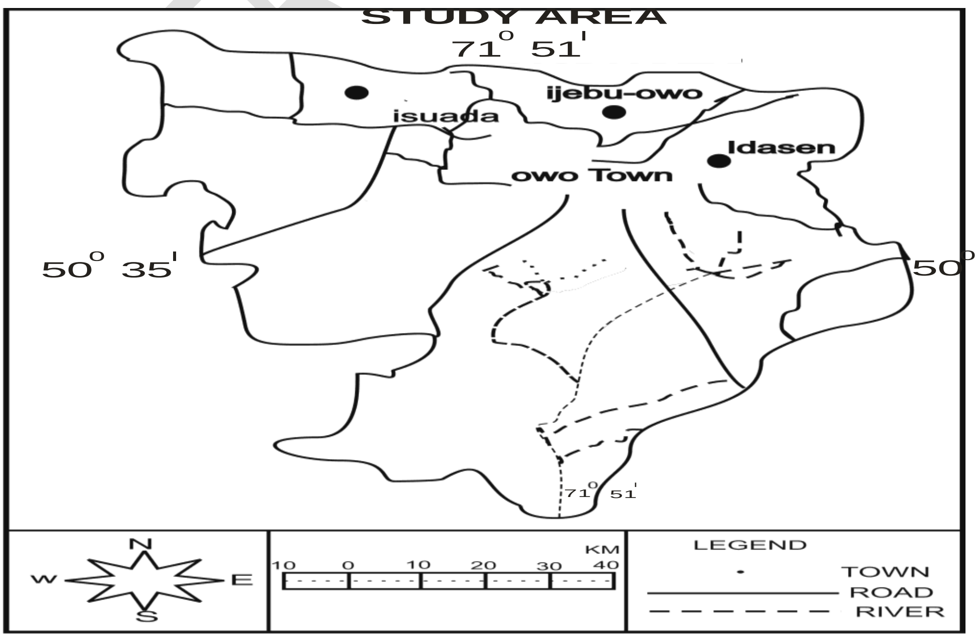

Figure 1: Map of Owo local Government showing the selected study area

Plate 1: Termite Mound Soil at Ijebu Site

Field Experiment

The experimental sites selected in Owo are Ijebu, Idasen and Isuada because there are abundant termitaria in these areas.The design used was Randomized completely Block Design (RCBD). Nine beds were prepared; each of the bed (4 m by 4 m) is for the termites mound soil, the surrounding soil, and for the mixture of the surrounding soiland the termite mound soil.6 stands of maize plants were cropped on each bed and on specific stand readings were taken. The termites mound soil was broken into smaller particles and spread on thin nylon sheet placed inside the ditch, covering the four vertical sides and the bottom of the ditch. This technique prevents any nutrient from the surrounding soil into the termite soil.Water was supplied to the seedbeds through drip irrigation. The same treatment was supplied to the soil of the three beds at the rate of 2 litres/hr.Weeding operation was carried out on the three beds for twice, thrice and four times on the termite soil, termite soil plus the surrounding soil, and the surrounding soil respectively. Germination took place on the beds after planting (termite mound soil, surrounding soil, and the mixture of the soil of termites and surrounding soil beds). The germination date for the three groups of the experimental soils were noted, the results for the experimental soils were recorded weekly. The length, breadth, the distance between nodes of the maize and the yields were noted and recorded accordingly. Plots 2, 5 and 8 represent the mixture of termite mound soil and the surrounding soil, plots 1,4 and 7 represent the termite mound soil and while plots 3, 6,9 represent the surrounding soil (Figure 2).The following steps were considered for forming the blocks:

1) No of treatment is 3

2) No of replicate is 3

3) No of total experiment is 9

By using a standard random number table, the plots would stand as presented in Figure 2.

Maize Cultivation

Effort was geared towards determining the agronomic parameter of maize cultivated on termites mound soil, mixture of termite soil and surrounding soil (50 : 50 per weight) using Completely Randomized Block Design (CRBD) as depicted in Table 1. The empty colony was grounded, spread on a thin nylon rubber sheet placed in a ditch, covering the bottom and the four vertical sides protruding to the surface forming a bed. This technique prevented the soil nutrient from the surrounding soil entering the termite soil. On this, maize crop was cultivated together with the two other beds (the surrounding soil and the mixture of termite soil and the surrounding soil).

Table 1: The random number, sequences and ranking

Random number	Sequence	Rank
055	1	2
824	2	8 A
007	3	1
795	4	7
892	5	9 B
697	6	5
237	7	4
021	8	3 C
720	9	6

Step 3

A – 2, 8, 1

B – 7, 9, 5

C – 4, 3, 6

Step 4

1 A	2 A	3 C
4 C	5 B	6 A
7 B	8 A	9 B

Treatment Method

The methods used for the treatment are weeding and application of water to the plant on the beds. The treatments were applied to the plant as follows:

i. On plots 1, 3, 7 which were termite mound soil, weeding application to the bed was twice.

ii. On plots 2, 5,8 which are termite mound soil plus surrounding soil, weeding application to the bed was thrice.

iii. On plots 3,7,9 which is surrounding soil, weeding application to the bed was four time.

iv. Water application to all the beds was the same.

Determination of the rooting depth

The grids intersect techniques method was used to obtain the rooting depth:

i. The root of the maize plant was uprooted from the beds (2 plants each).

ii. Trace the roots on paper, measure each of the tracing and calculate root length

iii. A ruler was used to measure the length of the root(tap root) from the tracing paper

iv. The result is the rooting depth of the plant

Water supply to the maize field

Drip irrigation was used for the supply of water to the plant. This irrigation system was chosen because it is concise, accurate and direct in delivery of water to the root zone of plant as observed by Scott (2018) and Dyer (2016). The emitters are directly responsible for the controlling of water directly to the root of plant and it can emit 2 litres of water in an hour. They are different root depth for various plants. The root depth of the planted maize on the different beds (plots 1, 2 3) are approximately TMS-22 cm, TMS + SRS- 28 cm and SRS – 19 cm. This determined depths falls within the range as presented in literature. It was observed that the root type of maize is fibrous root which spread in the soil. The application of water through drip irrigation was done early in the morning and late in the evening. This is because evapotranspiration (ET) is very high in the afternoon (hot weather) than in the morning and evening (cool weather) from the surface of the ground, leaves and tissues of plant. The area of planting was chosen considering some factors. These factors are accessibility of the area, abundance of termitaria, availability of water in the environment and proximity for proper monitoring. The drip irrigation used for the supply of water to the maize at the developmental stage is presented in Plate 2.

Plate 2: Drip irrigation supplying water to Soils at the developmental stages

RESULTS AND DISCUSSIONS

Growth parameter of maize at Isuada

Mixture of the termite mound soil and the surrounding soil (plots 2,5,8) was richer in plant nutrient than the sole termite mound soil and the surrounding soil Figures 2, 3 and 4. The termite mound soil revealed that maize plant cropped on it gave higher growth and yields parameter than the surrounding soil as presented inFigures 2, 3 and 4. This finding on the field is similar to the claim of Rupela*et al.,* (2006) who reported that

African farmers collect termite mound soil and apply to cropped fields as it can be rich in available nutrients. This shows that the nutrients in termite mound soil together with the nutrient in the surrounding soil boast the growth and the yields of the maize crop cultivated in plots 2, 5 and 8. This therefore revealed that agriculturist should add and mix termite mound soil as a natural fertilizer to the surrounding soil for crop cultivation. From the Tables and the Figure presented, it could be deduced that the developmental rate of the maize seed planted on the termites soil varied rapidly when compared to that recorded on the surrounding soil. The graphs in Figures 2, 3 and 4 shows the developmental trend which the growth pattern followed and this same trend is what all the growth on the other plots takes with little variations when plotted. Physically on the field as shown in Plate 1, a healthier growth was noticed on the maize cropped on the termites mound soil than the surrounding soil.The yields of maize cultivated on plots 1,4 and 7 (TMS+SRS); 3,6,9 (SRS) using t-distribution test were $0.75<\mu<1.87$ or 1.31 ± 0.56; $1.68<\mu<2.92$ or 2.30 ± 0.62; $0.75<\mu<1.25$ or 1.00 ± 0.025.Completely Randomized Block Design was used for the experiment and the analysis of the variance was obtained based on the number of time weeding was carried out on the plots. The treatments (weeding on the beds which vary for TMS-twice, TMS +SRS-thrice and SRS-fourth with same application of water) were three and the numbers of replicates were three for the soils. ANOVA Table was constructed for Completely Randomized Block Design as presented in Table 1. The assumed level of significant is 0.05. Since $\alpha = 0.05$, treatment d.f =2 and Error d.f =6. Then, the critical (Ft) value is 5.14. Since 0.24 is less than 5.14, there is no significant difference in the mean yields at 5% but at the same 5%, 5.3 is greater than 5.14 which means there is significant difference in the yield of maize. In other words, since 5.14 is greater than0.24 and 5.14 is less than 5.3, there is and or no significant differences in the mean yields of maize within the blocks at treatments at

5% level.Since 5.14 > 0.24 there is significant differences in the mean yields at 5% but at the same 5%, 5.14 < 5.3 which means there is no significant difference. In other word, since 5.14 >0.24 and 5.14 < 5.3, there is and or no significant differences in the mean yields of maize within the blocks at treatment at 5% level.

Table 2: Yield of maize under different Weeding time calculation

Treatment (Weeding Time)	**Block**			**Treatment Total (Y_t)**	**Mean ($\overline{Y_t}$)**
Twice	1	2	1	4	1.33
Trice	2	2	3	7	2.33
Fourth	1	0.5	1	2.5	0.83
Block total (Y_b)	4	4.5	5 = 13.5.	13.5	1.49
Block Mean	1.33	1.5	1.67	1.49	

Table 3: ANOVA table for Completely Randomized Block Design (Analysis of Variance)

Source of Variation	Degree of freedom	Sum of squares	Mean square	Observed F	Required F
Total	8	5			5%
Block	3	0.17	0.8	0.24	5.14
Treatment	2	3.5	1.75	5.3	
Error	6	1.33	0.33	0	0

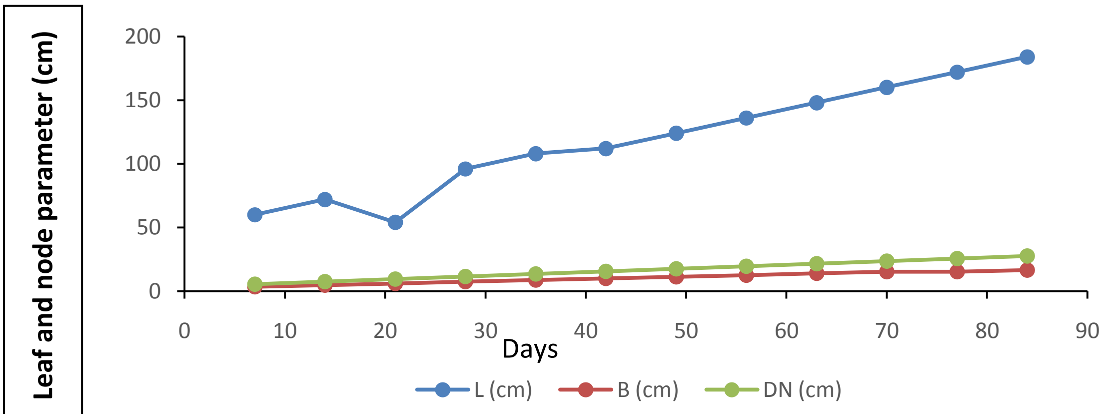

Figure 2: Growth rate of maize crops cropped on termite mound soil

L ---- Le h, B ---- Breadth, DN ---- Distance betwe nodes

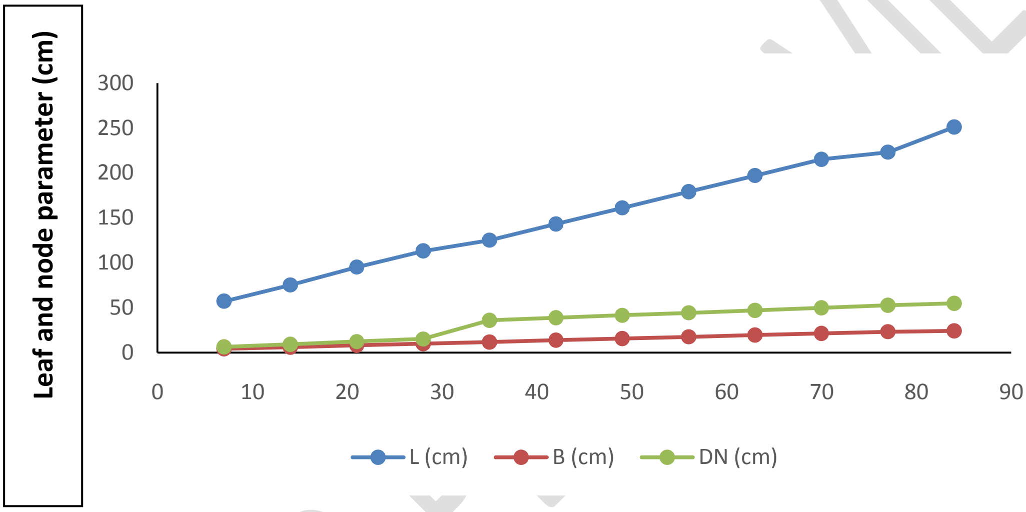

Figure 3: Growth rate of maize crops cropped on Termite Mound Soil and Surrounding soil

L ---- Length, B ---- readth, DN ---- istance between nodes

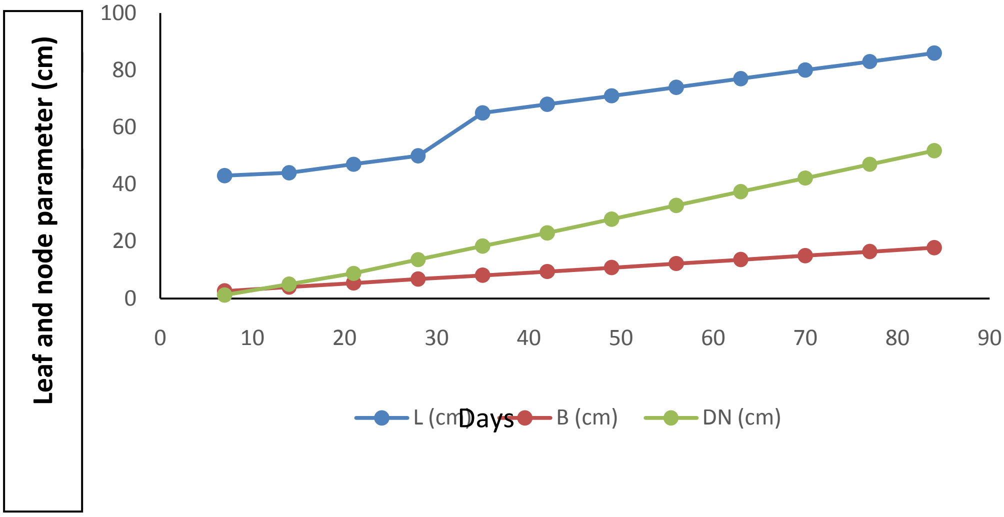

Figure 4: Growth rate of maize crops cropped on Surrounding soil

L ---- Len[illegible] B ---- bread[illegible] DN ---- Distan[illegible]between nodes

Plate 3: Maize crop on Termite Mound Soil

Plate 4: Maize crop on Termite Mound Soil and Surrounding Soil

Plate 5: Maize crop on Surrounding Soil

The benefits of termite mound soil to the farmers are very important since the mound is rich in soil nutrient. Their nutrients boost the growth and the yields of plant. This claim was derived from this work. The infiltration rate of the mounds were high in some experimental sites, hence it will reduce soil erosion. Due to the high shear strength values of the mound, it can be used for constructional purposes to produce local materials such as bricks, silos and plastering purposes.

CONCLUSION

An experiment for the cultivation of maize crop on grounded empty colony of termite's soil, mixture of termite mound soil plus the surrounding soil and the immediate adjacent soil was carried out on the field in Owo Local Government area of Ondo State, Nigeria. It was closely observed that a healthy growth and better yields were noticed on maize cropped on the mixture of termites mound soil and the surrounding soil than the termite soil and the adjacent surrounding soil. It was concluded that economic benefits can also be derived from termites and its empty colony as reported in this study.Since termites mound soil is very rich in soil nutrients and it has been stated in literature to be so, it could be used as an organic amendment instead of using inorganic fertilizer which may be harmful both to human being and other soil organisms at the long run.The termitarium can be used as soil amendment such as nutrient recycling and manure by the agriculturist morestudies should be geared toward this social Insect (termites), for better things can still be revealed about them.Termites mound soil is very rich in soil nutrients and it has been stated in literature to be so, it could be used as an organic amendment instead of using inorganic fertilizer which may be harmful both to human being and other soil organisms at the long run.The termitarium can be used as soil amendment such as nutrient recycling and manure by the agriculturist since the moisture content (5.05-9.2), acidity (4.48-6.47), the pore space(6.62-11.04), the bulk density(0.99-1.38) and the chemical properties agreed with standard values and are well distributed throughout the mound.

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